Figure 1A

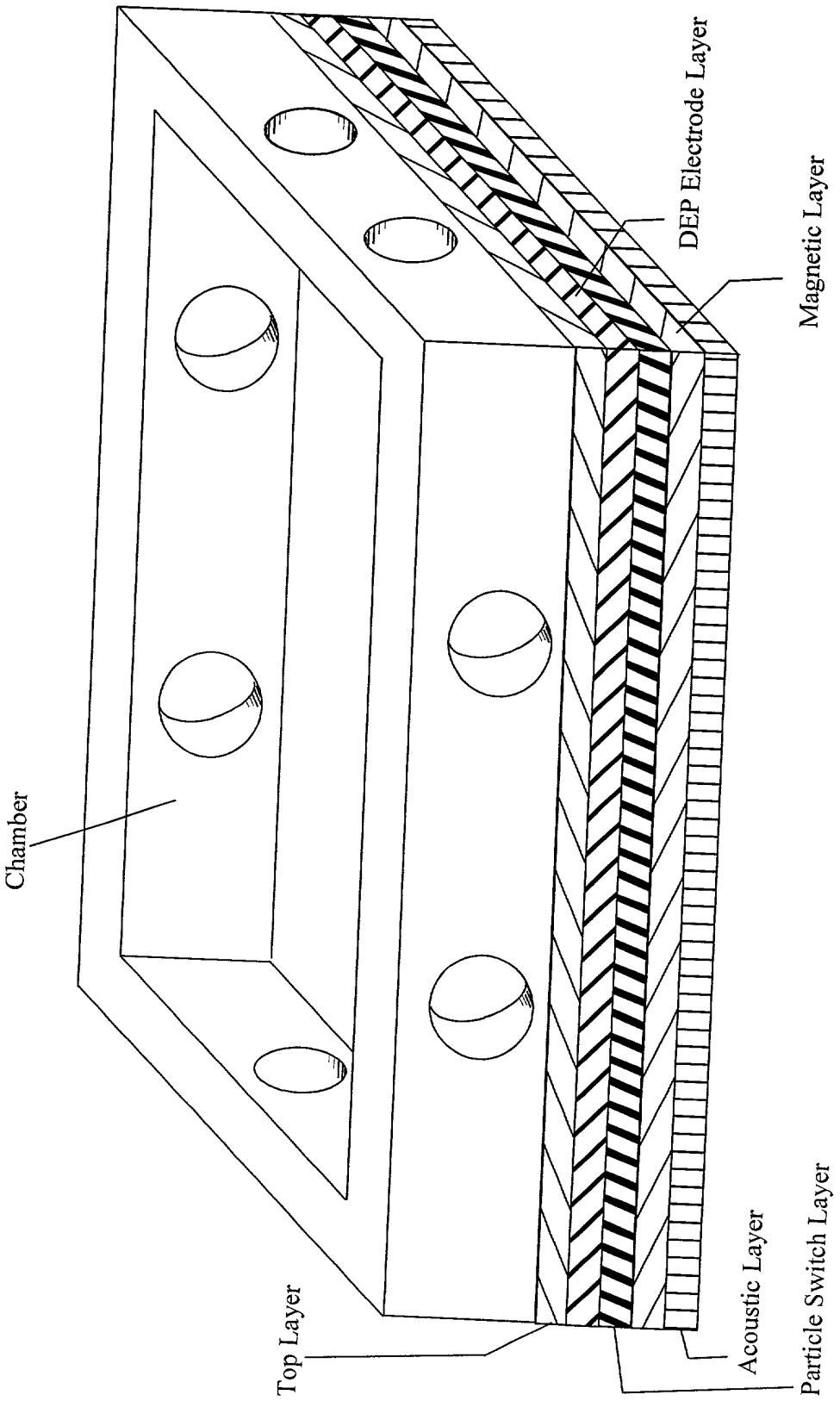

Chamber
DEP Electrode Layer
Magnetic Layer
Top Layer
Acoustic Layer
Particle Switch Layer

Figure 1B

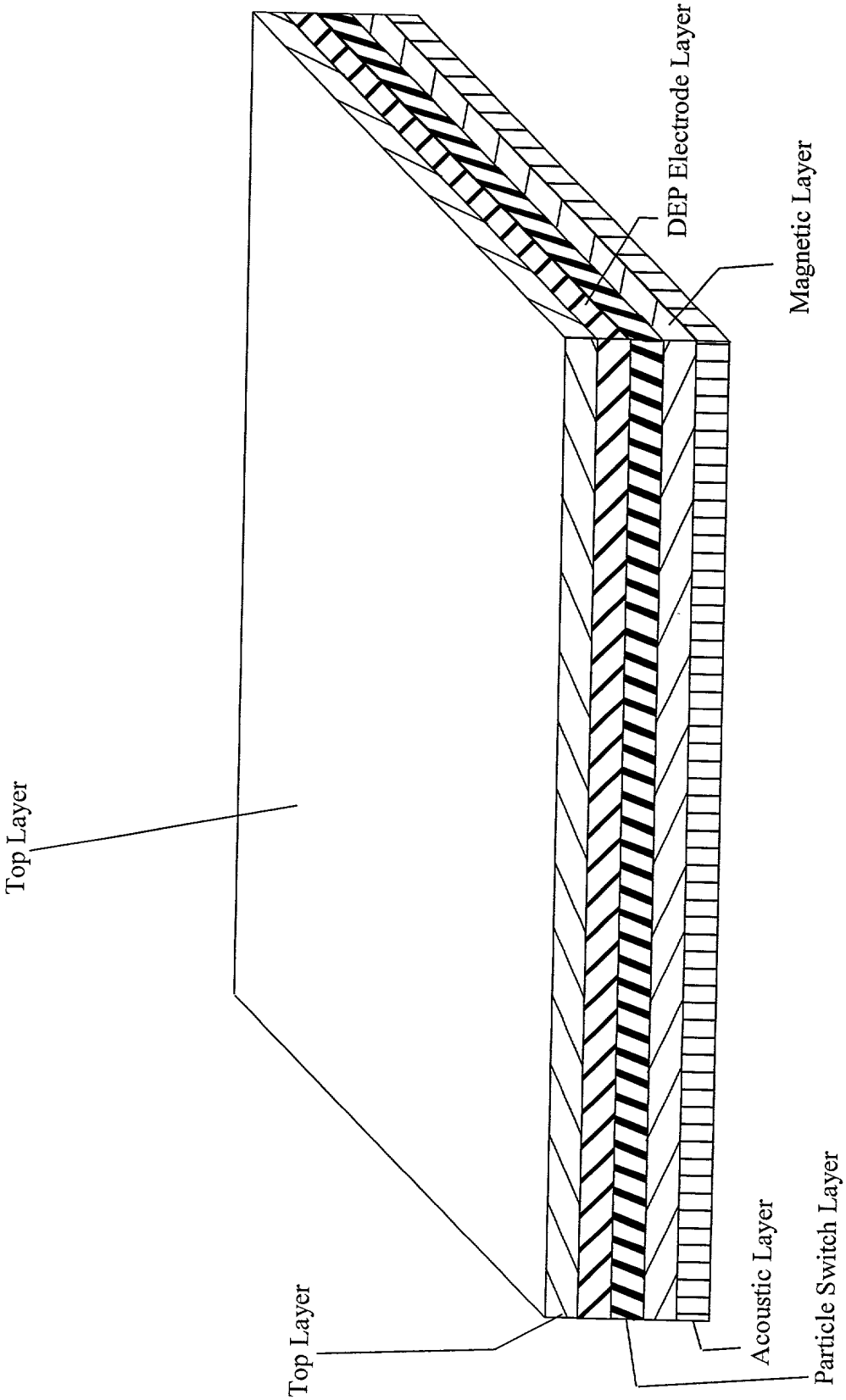

Top Layer
DEP Electrode Layer
Magnetic Layer
Top Layer
Acoustic Layer
Particle Switch Layer

Figure 1C

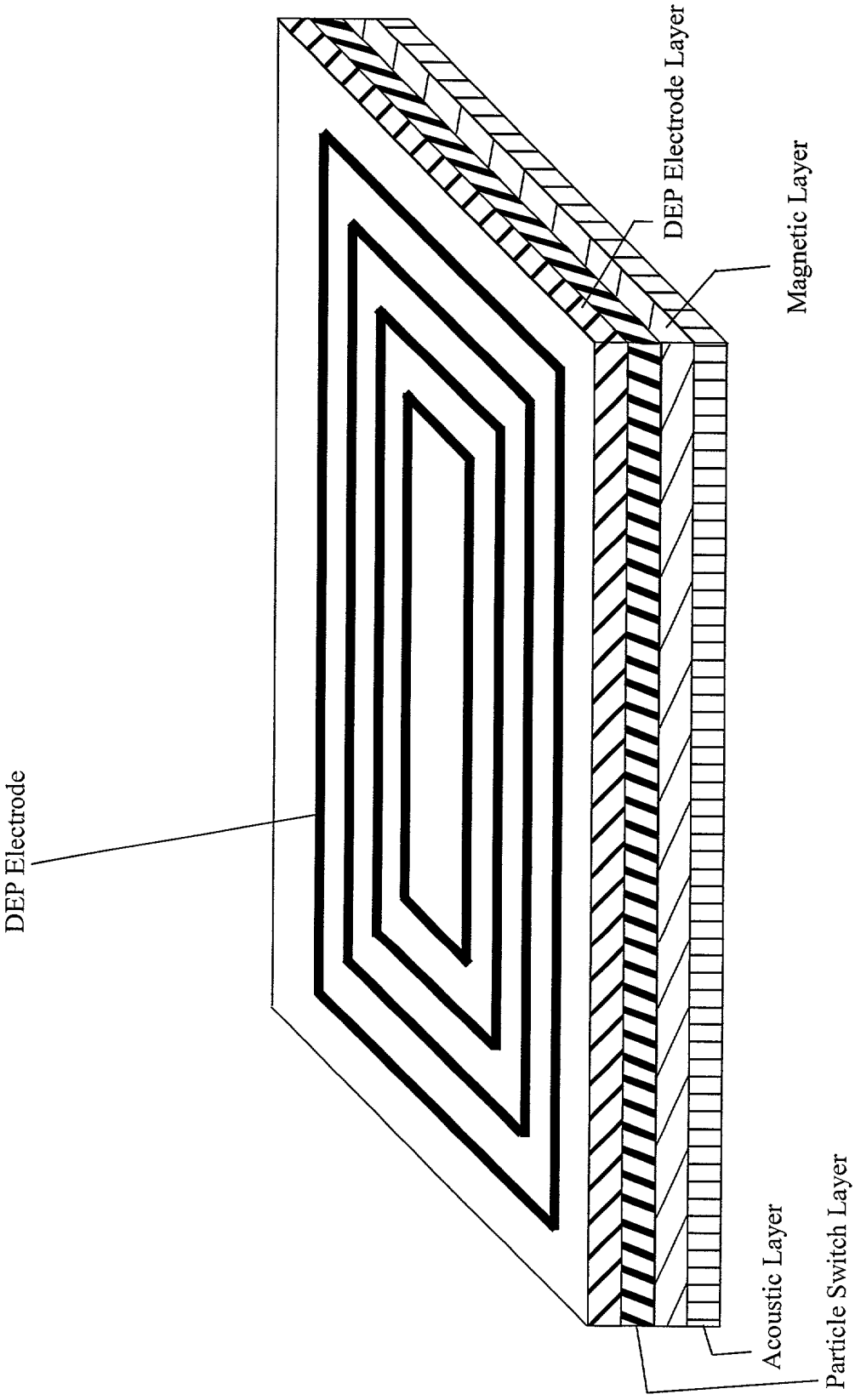

DEP Electrode
DEP Electrode Layer
Magnetic Layer
Acoustic Layer
Particle Switch Layer

Figure 1D

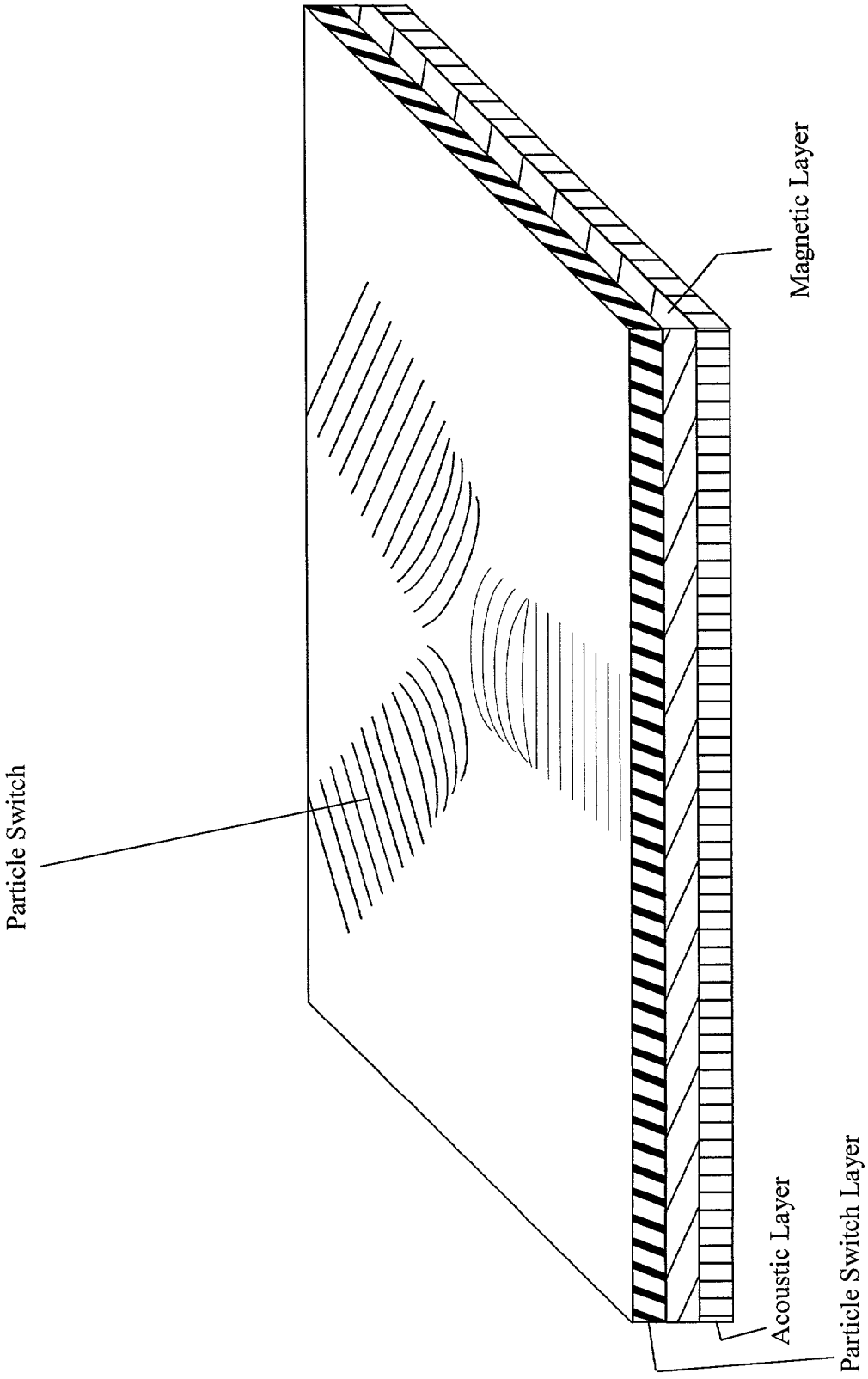

Particle Switch
Magnetic Layer
Acoustic Layer
Particle Switch Layer

Figure 1E

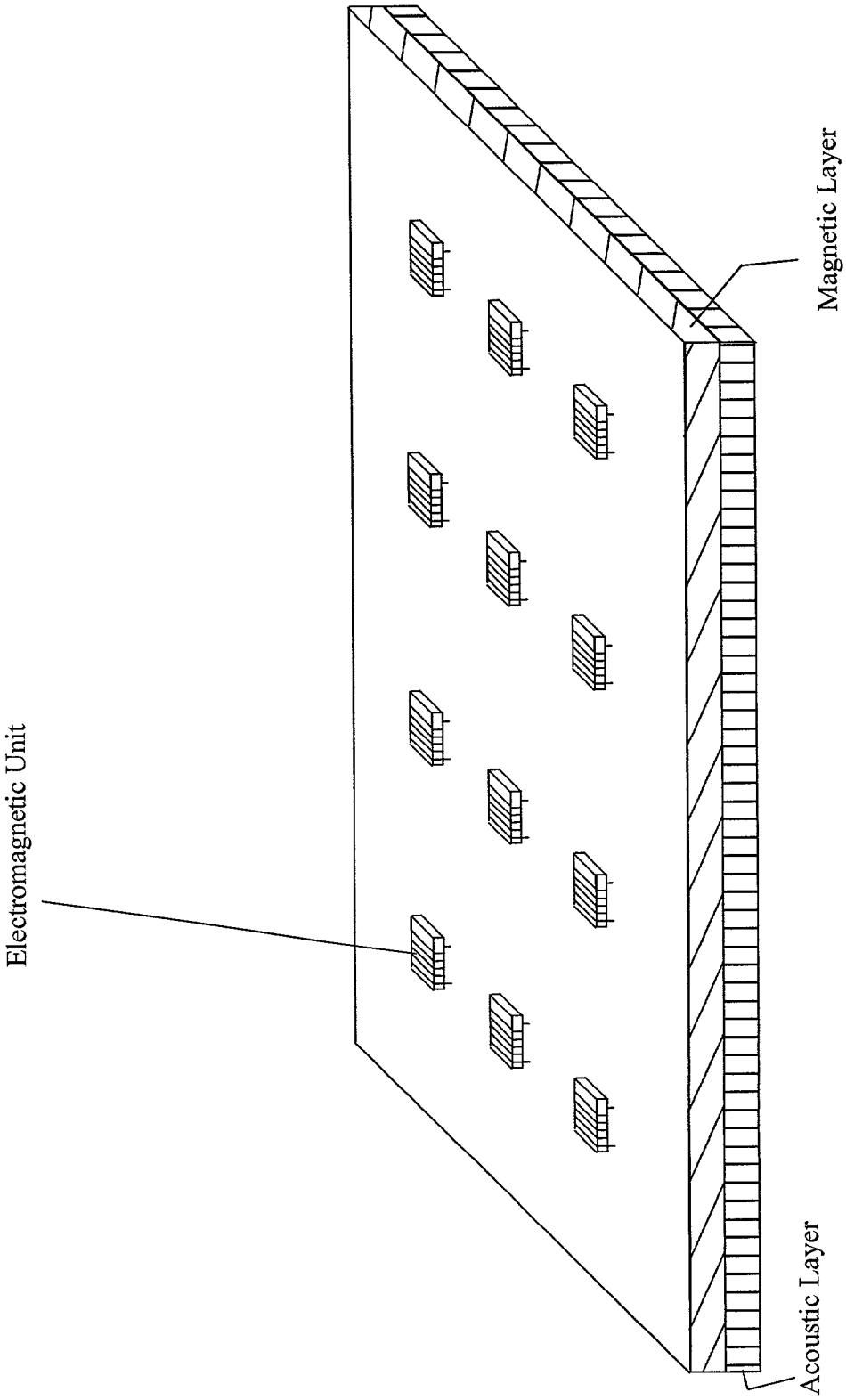


Figure 1F

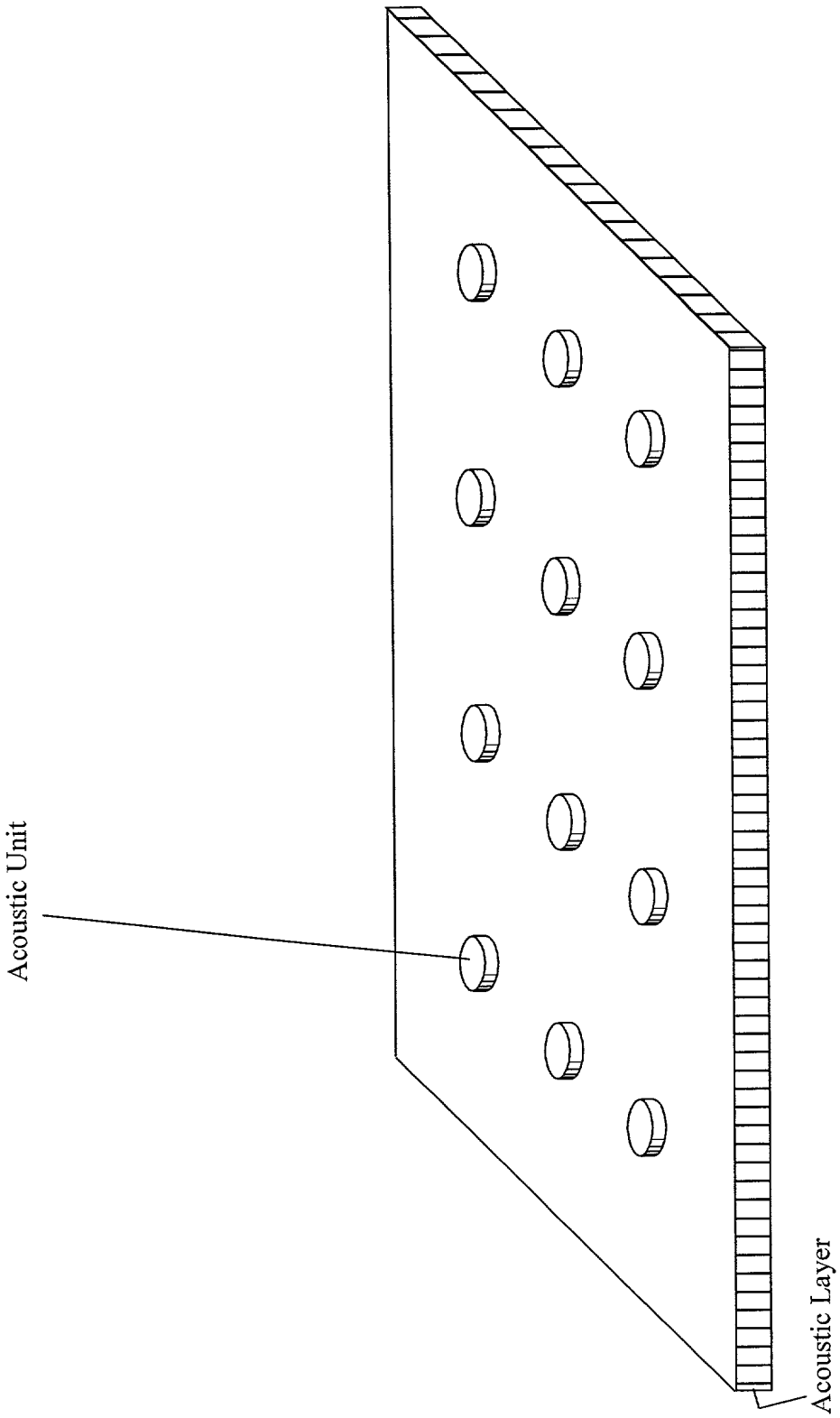
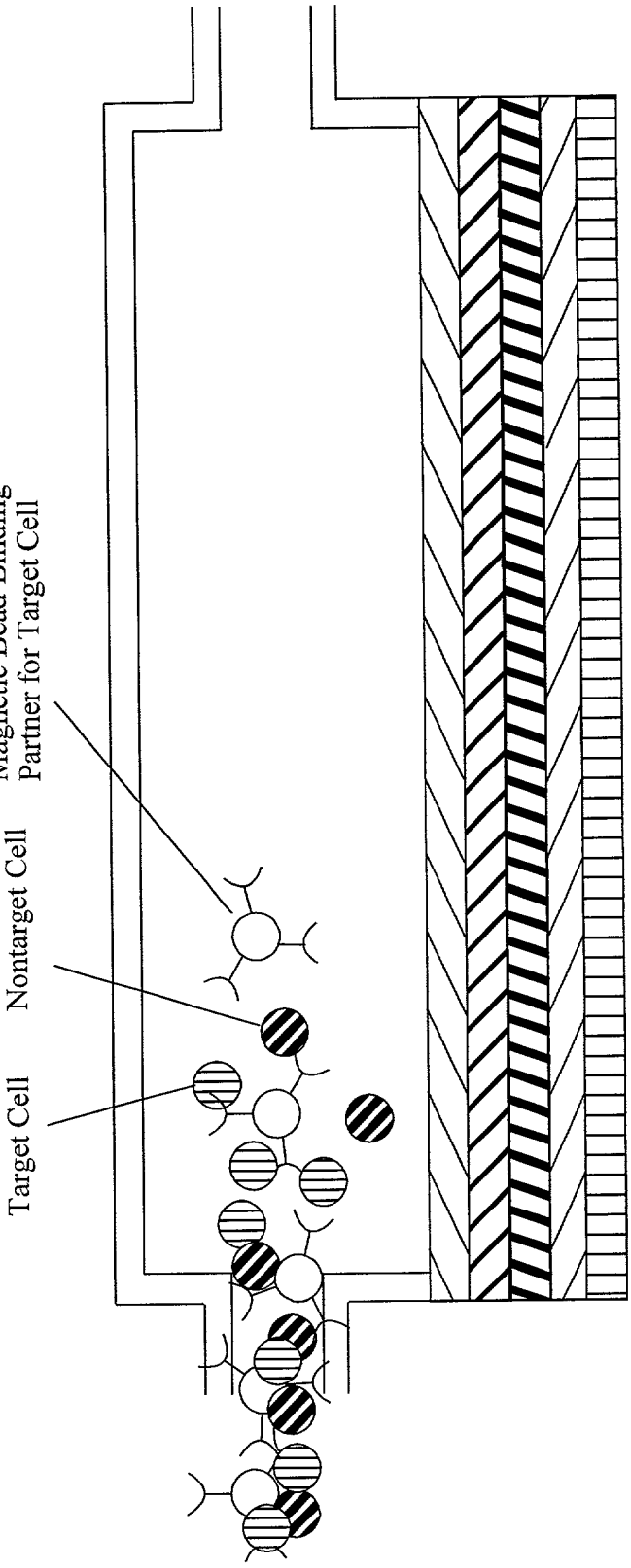


Figure 2A


Magnetic Bead Binding Partner for Target Cell
Nontarget Cell
Target Cell

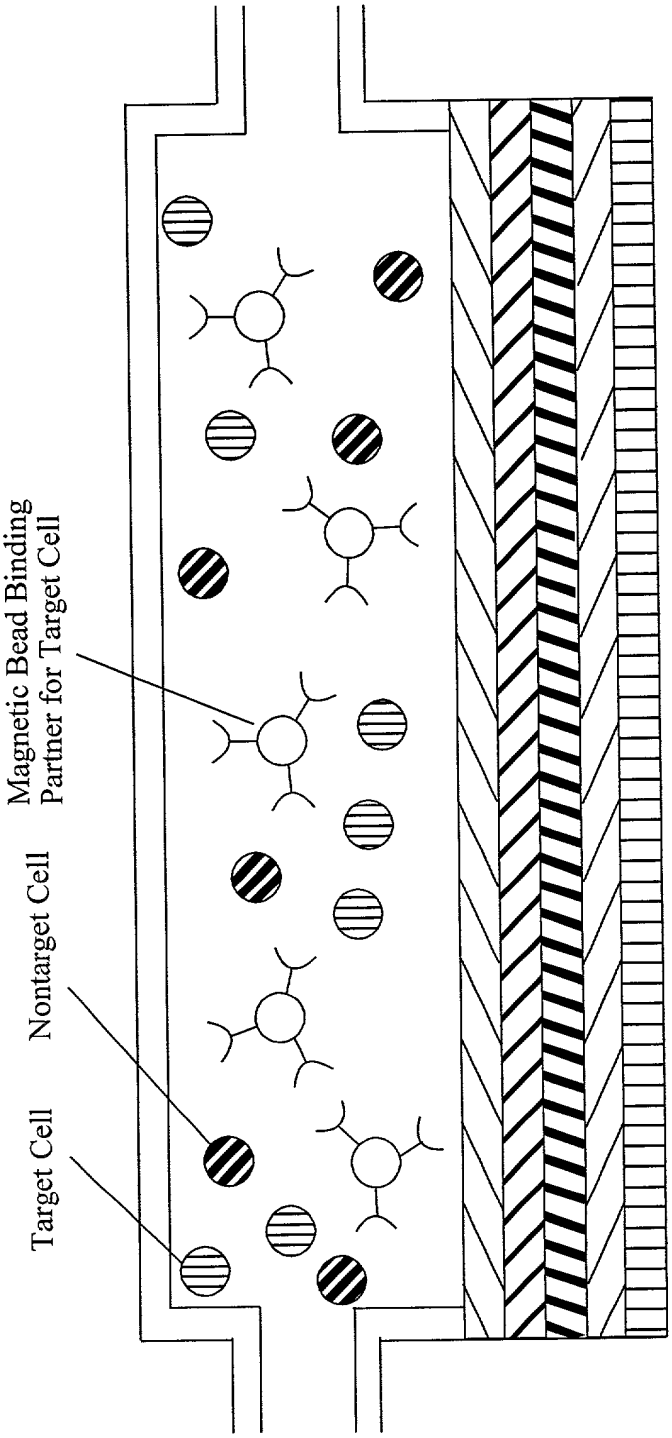

Magnetic Bead Binding Partner for Target Cell
Nontarget Cell
Target Cell

Figure 2B

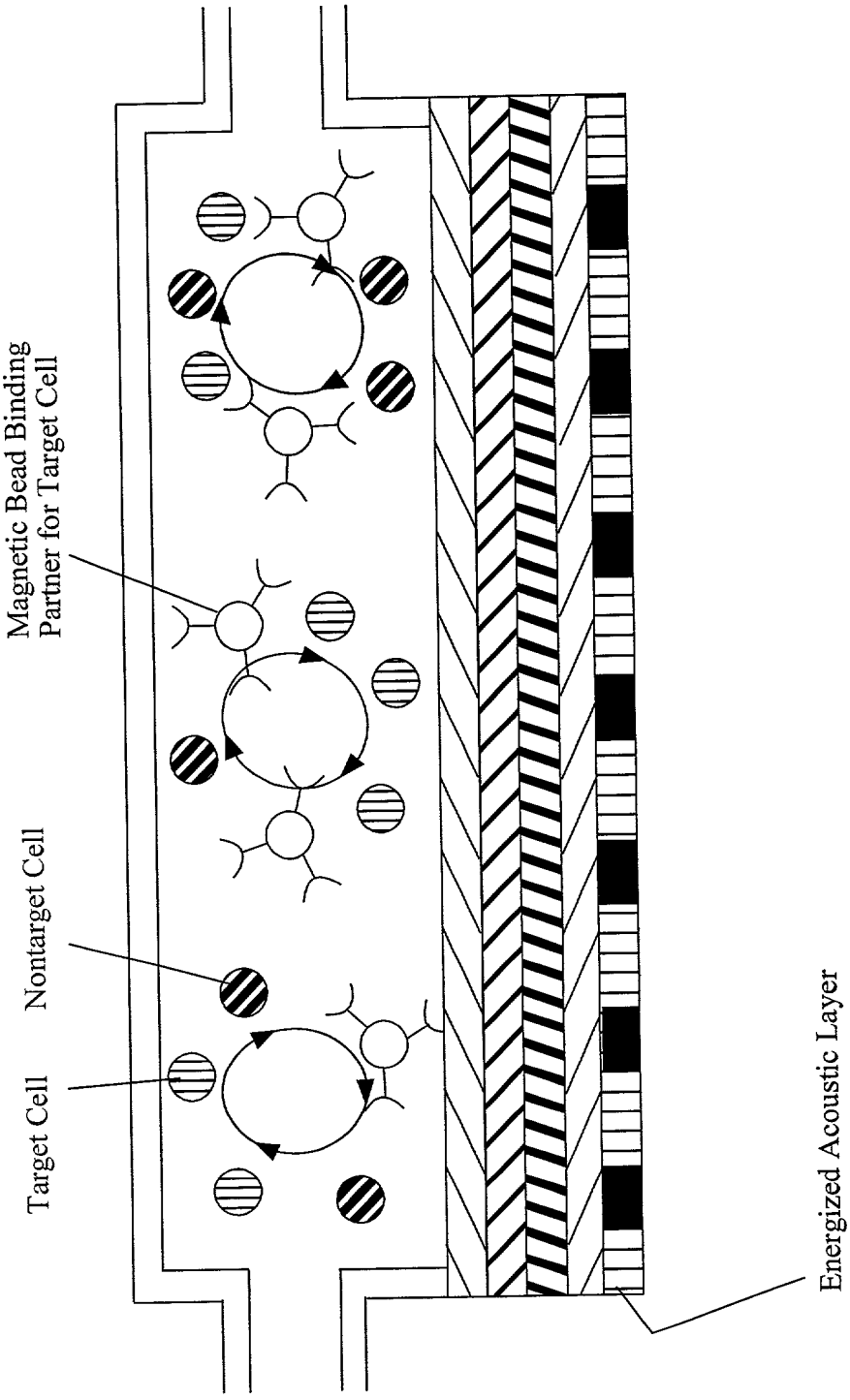

Magnetic Bead Binding
Partner for Target Cell
Nontarget Cell
Target Cell
Energized Acoustic Layer

Figure 3

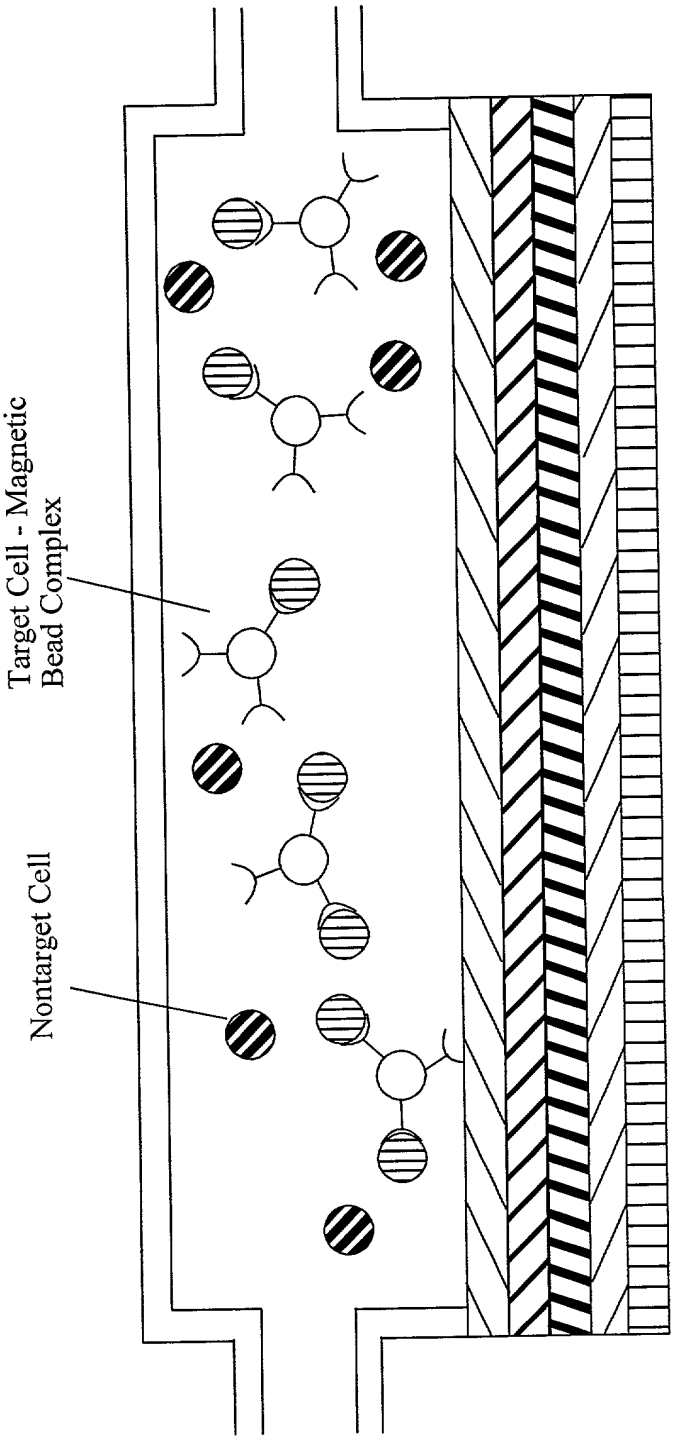
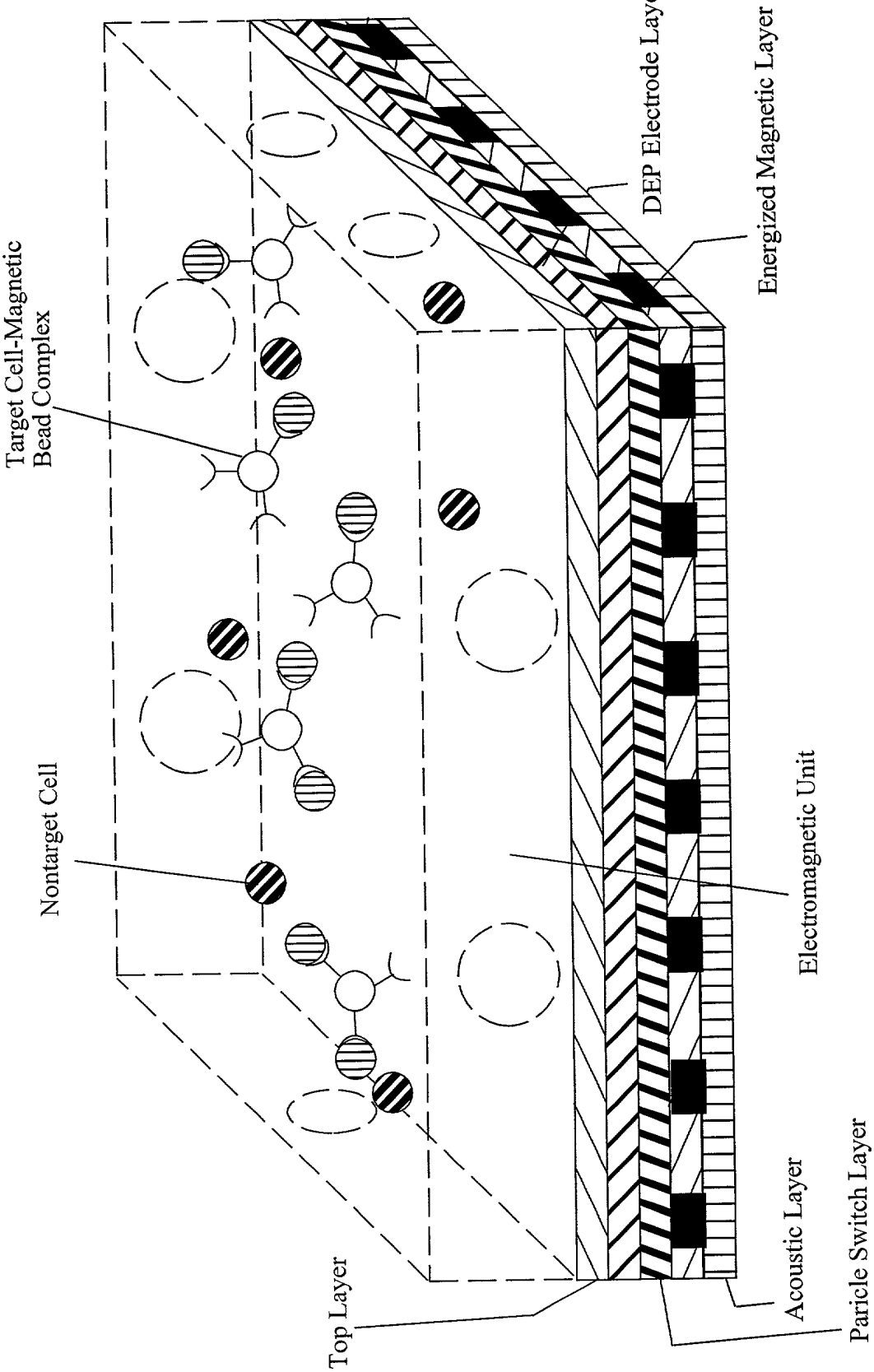


Figure 4

Figure 5A


Target Cell-Magnetic Bead Complex
Nontarget Cell
DEP Electrode Layer
Energized Magnetic Layer
Electromagnetic Unit
Top Layer
Acoustic Layer
Paricle Switch Layer

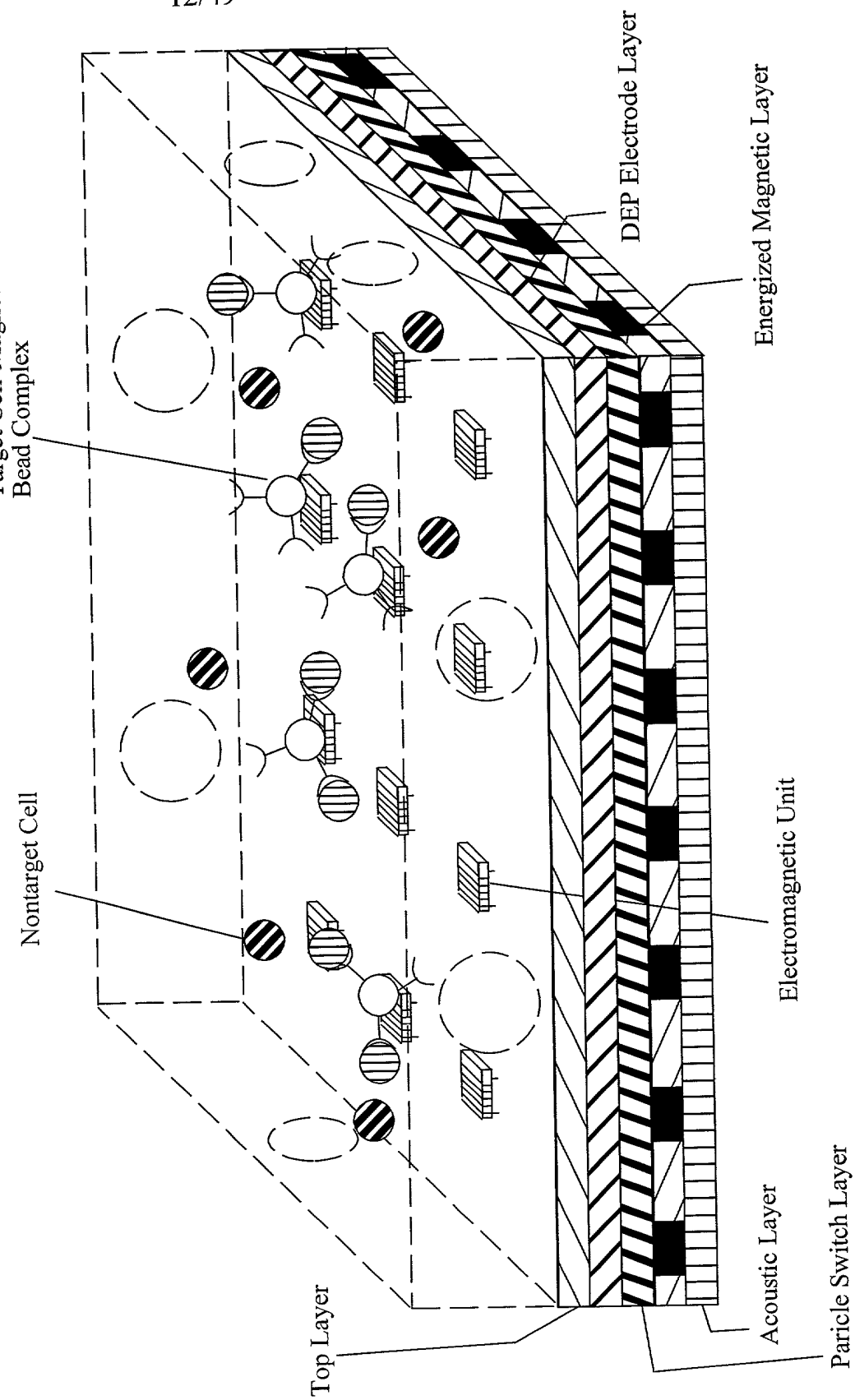

Target Cell-Magnetic Bead Complex
Nontarget Cell
DEP Electrode Layer
Energized Magnetic Layer
Electromagnetic Unit
Top Layer
Acoustic Layer
Paricle Switch Layer

Figure 5B

Figure 5C

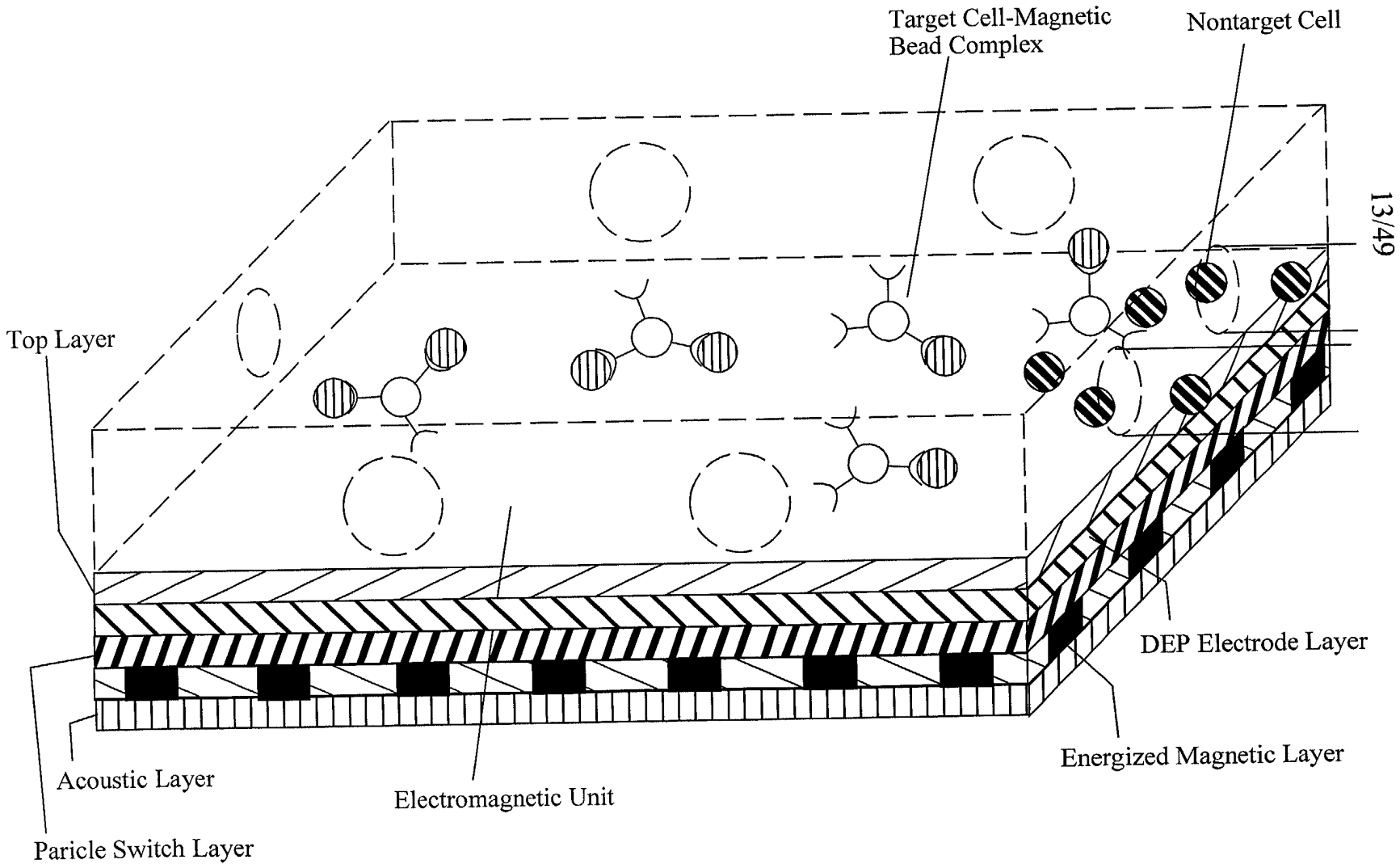
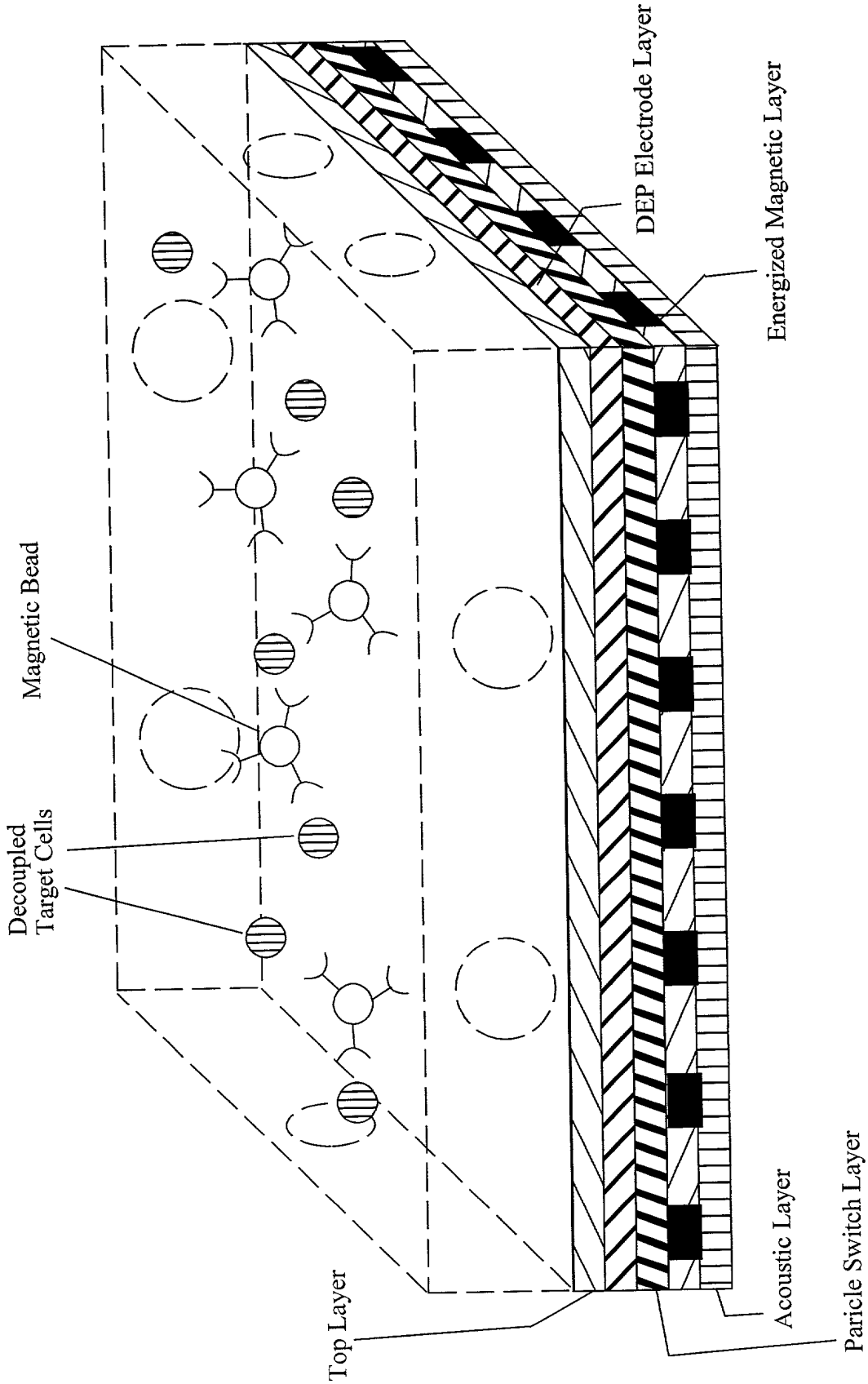

Target Cell-Magnetic Bead Complex
Nontarget Cell
Top Layer
DEP Electrode Layer
Energized Magnetic Layer
Acoustic Layer
Electromagnetic Unit
Paricle Switch Layer

Figure 6


Magnetic Bead
Decoupled
Target Cells
DEP Electrode Layer
Energized Magnetic Layer
Top Layer
Acoustic Layer
Paricle Switch Layer

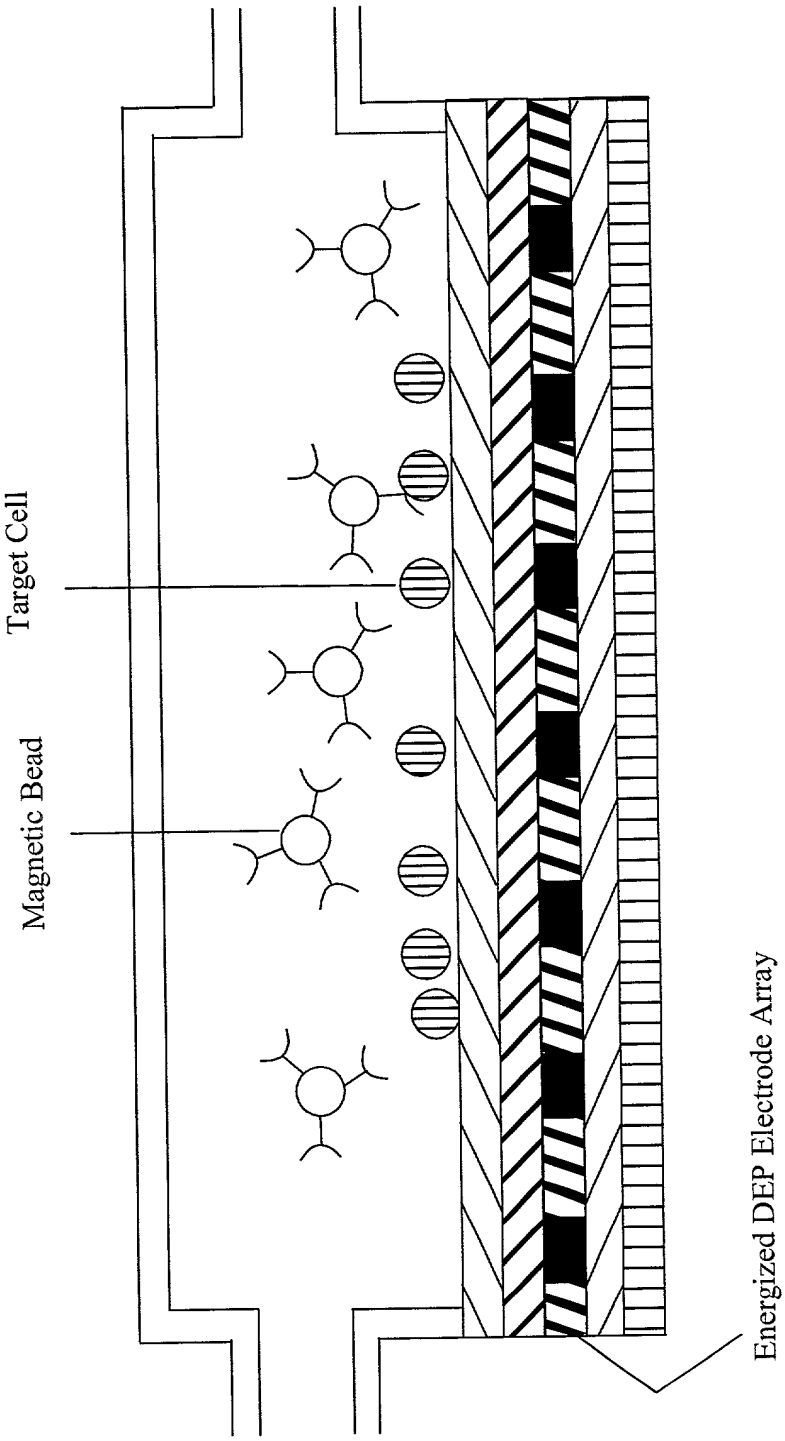


Figure 7A

Figure 7B

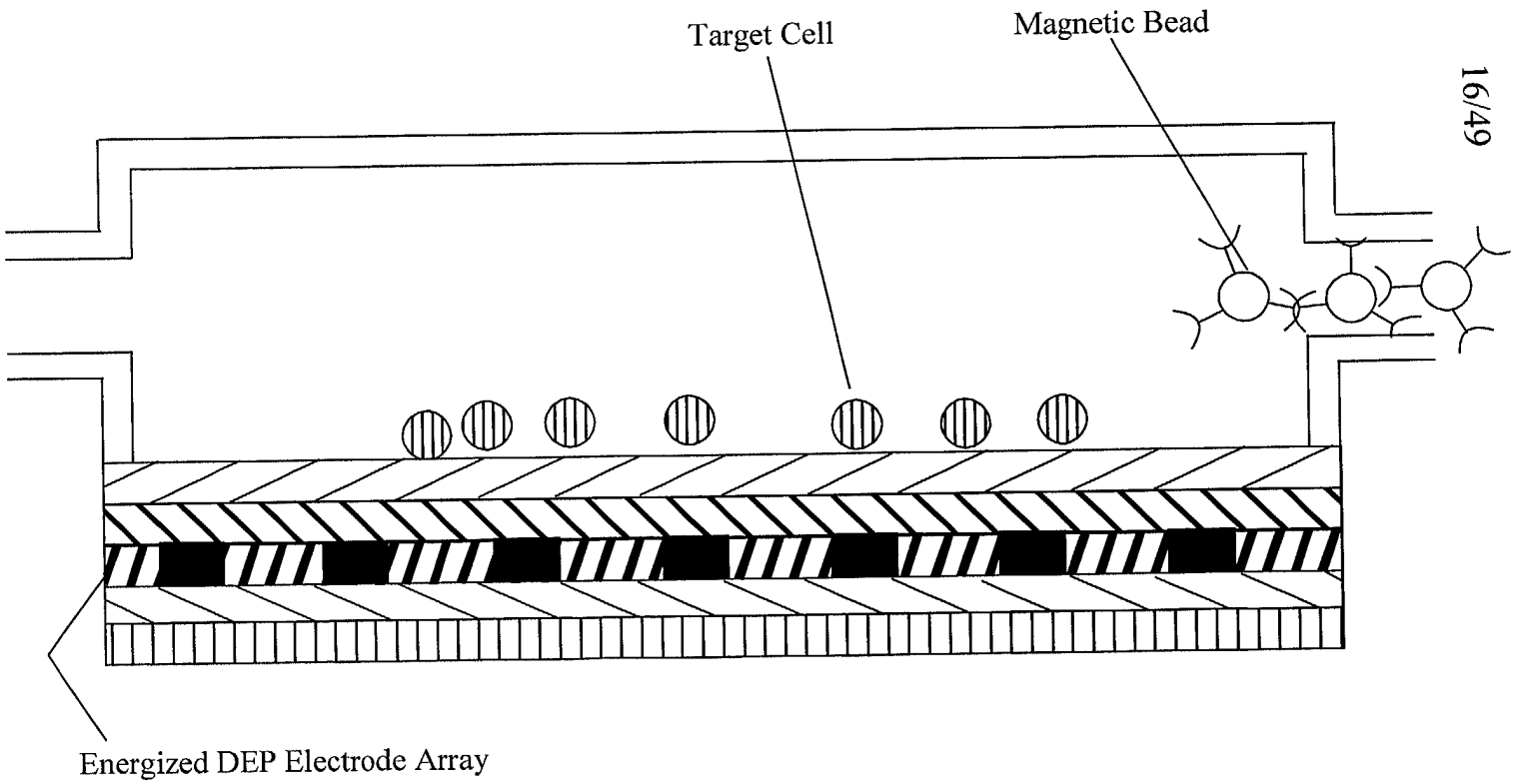
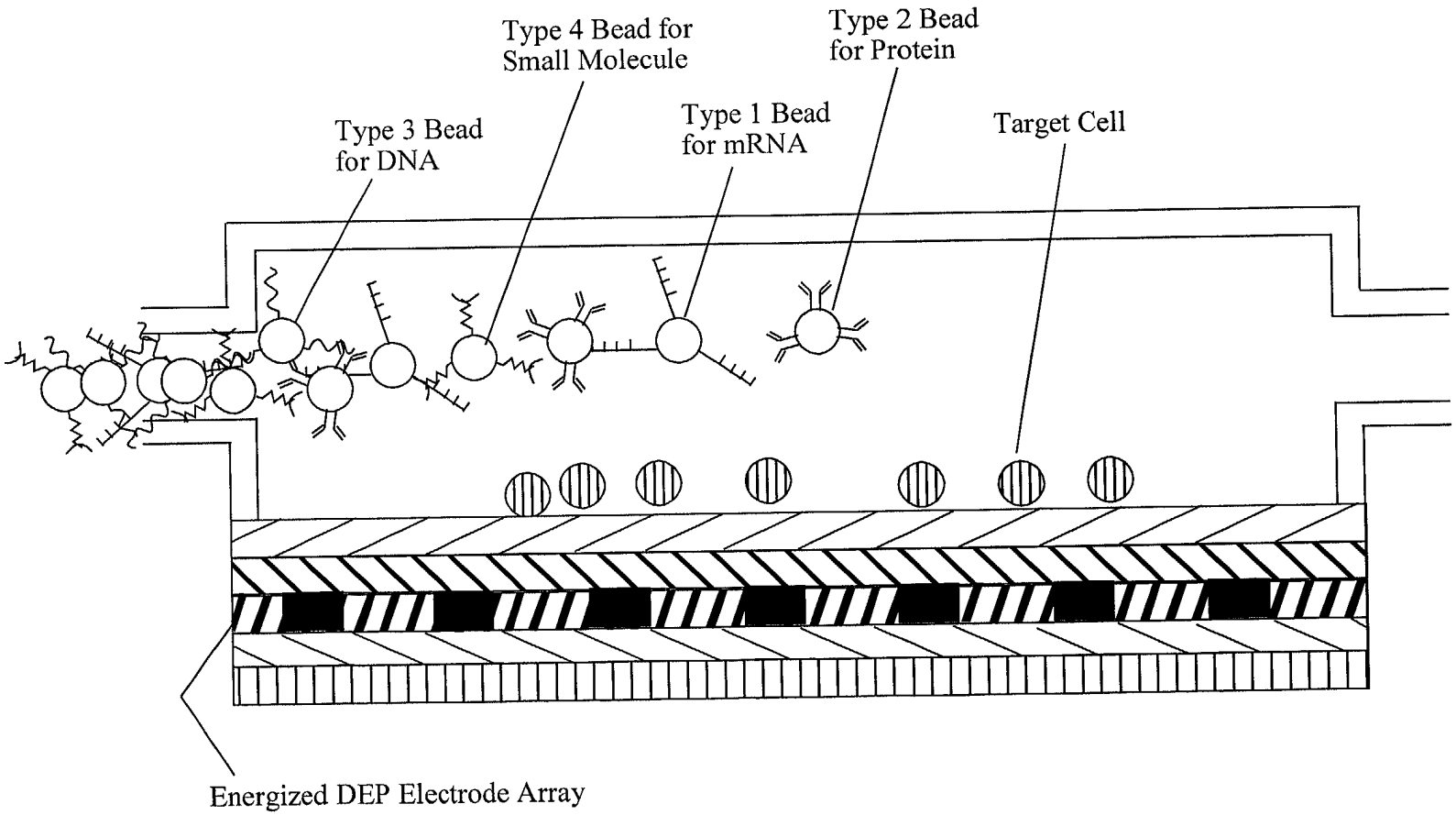


Figure 8



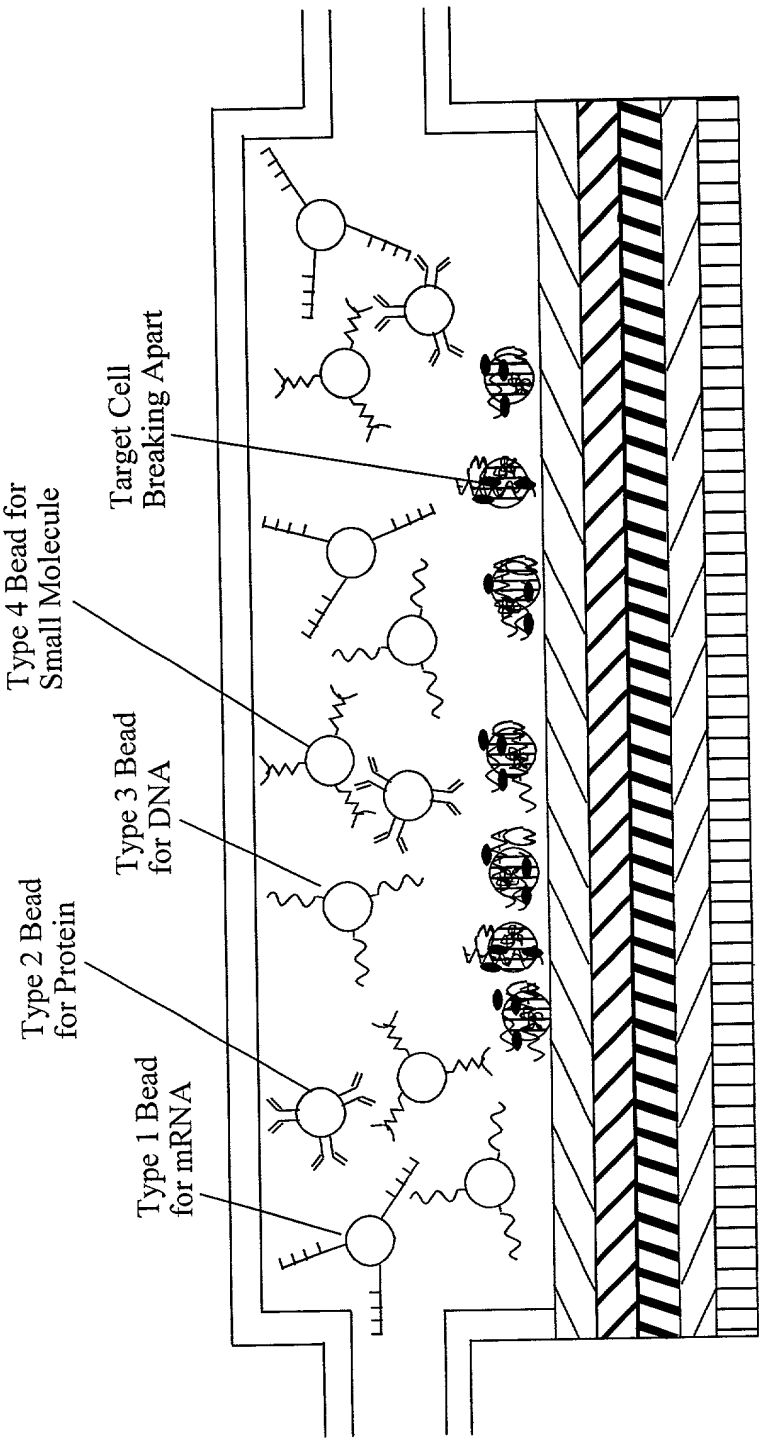

Type 1 Bead for mRNA
Type 2 Bead for Protein
Type 3 Bead for DNA
Type 4 Bead for Small Molecule
Target Cell Breaking Apart

Figure 9A

Figure 9B

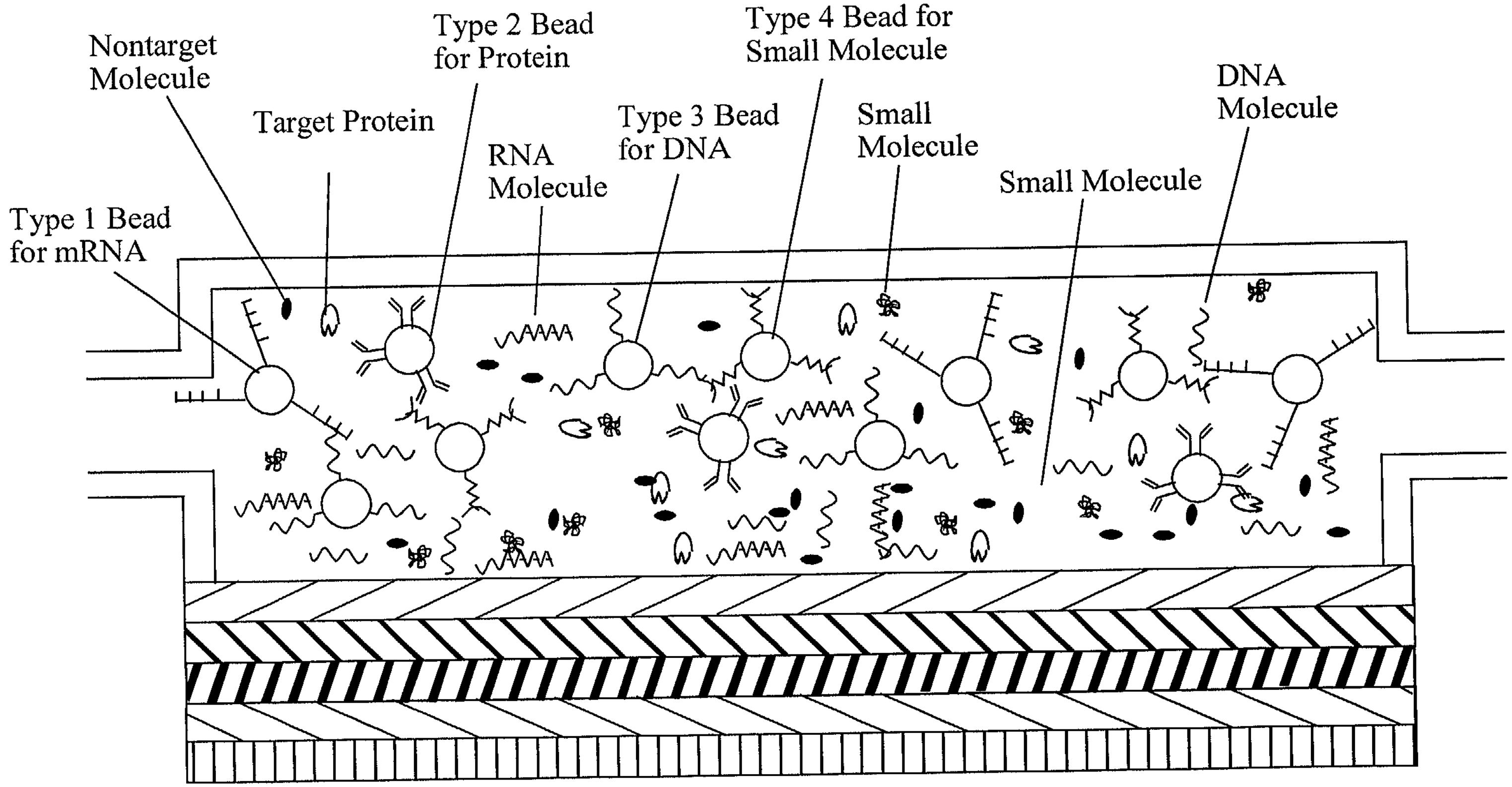
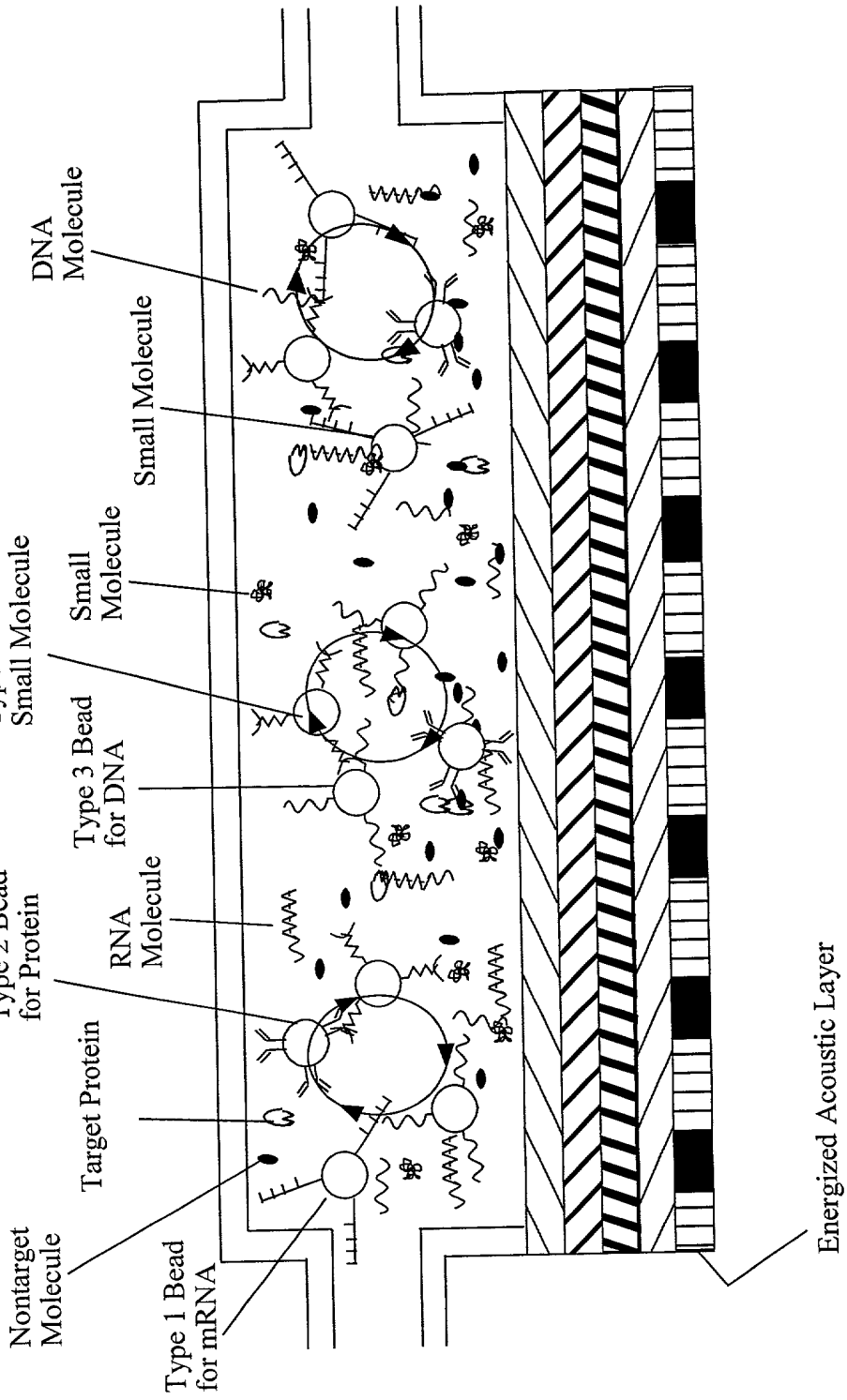

Type 1 Bead
for mRNA
Nontarget
Molecule
Target Protein
Type 2 Bead
for Protein
RNA
Molecule
Type 3 Bead
for DNA
Type 4 Bead for
Small Molecule
Small
Molecule
Small Molecule
DNA
Molecule

Figure 10


DNA Molecule
Small Molecule
Type 4 Bead for Small Molecule
Small Molecule
Type 3 Bead for DNA
Type 2 Bead for Protein
RNA Molecule
Target Protein
Nontarget Molecule
Type 1 Bead for mRNA
Energized Acoustic Layer

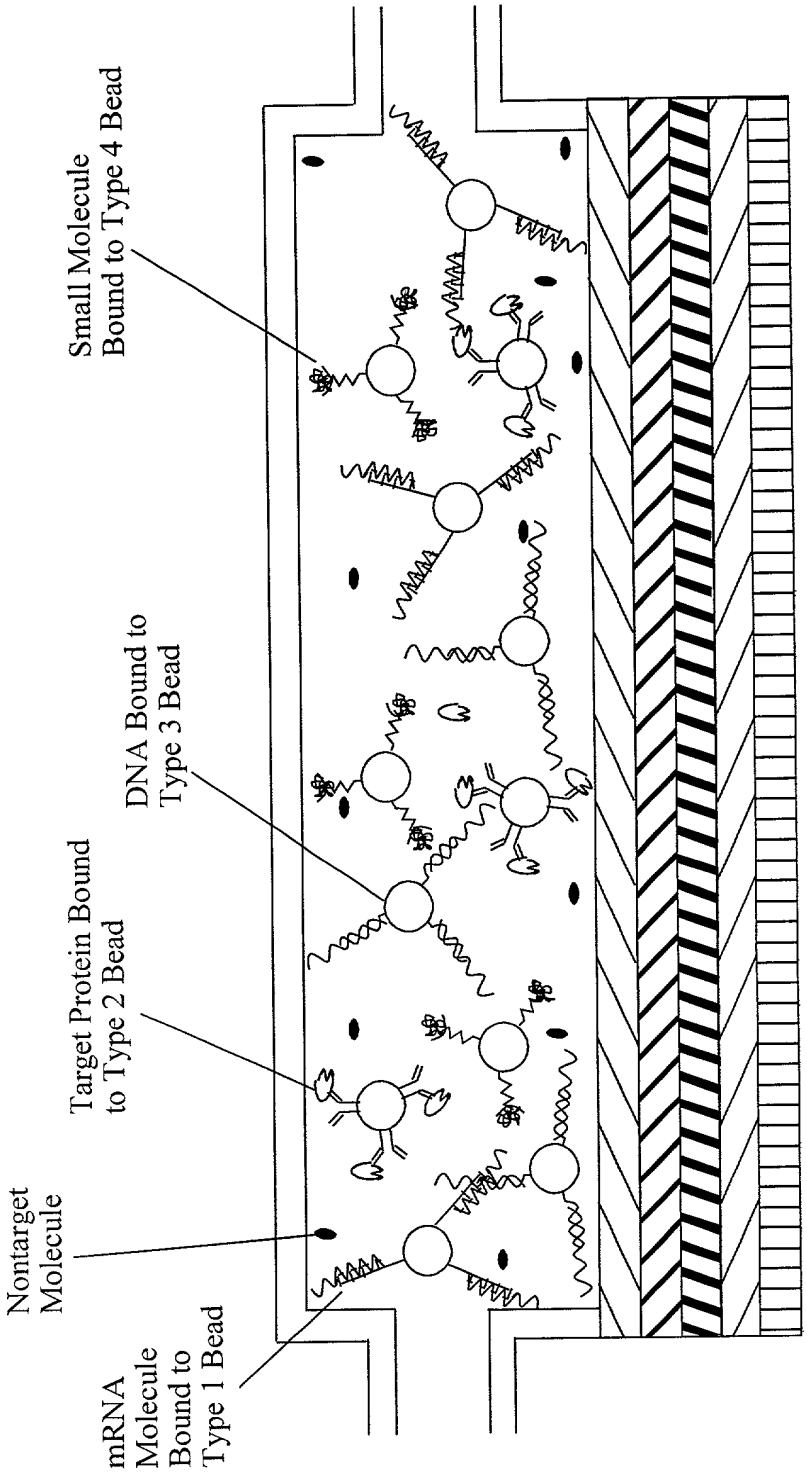

Small Molecule
Bound to Type 4 Bead
DNA Bound to
Type 3 Bead
Target Protein Bound
to Type 2 Bead
Nontarget
Molecule
mRNA
Molecule
Bound to
Type 1 Bead

Figure 11

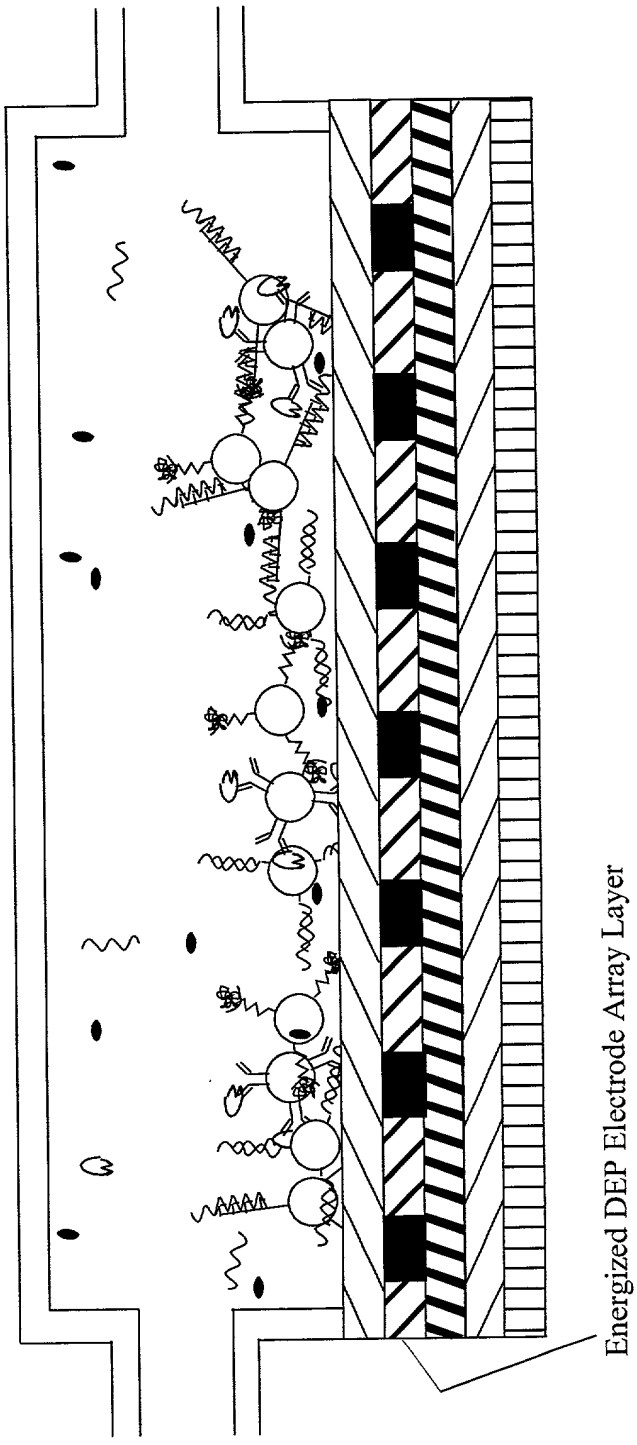


Figure 12A

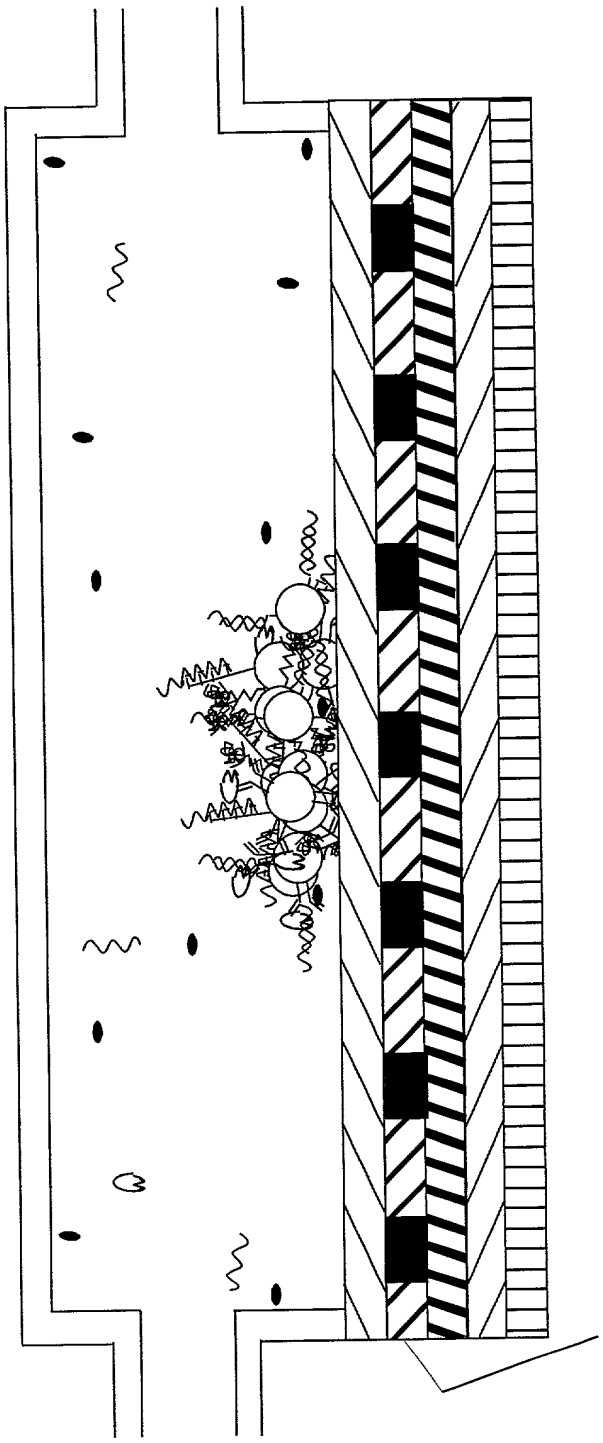


Figure 12B

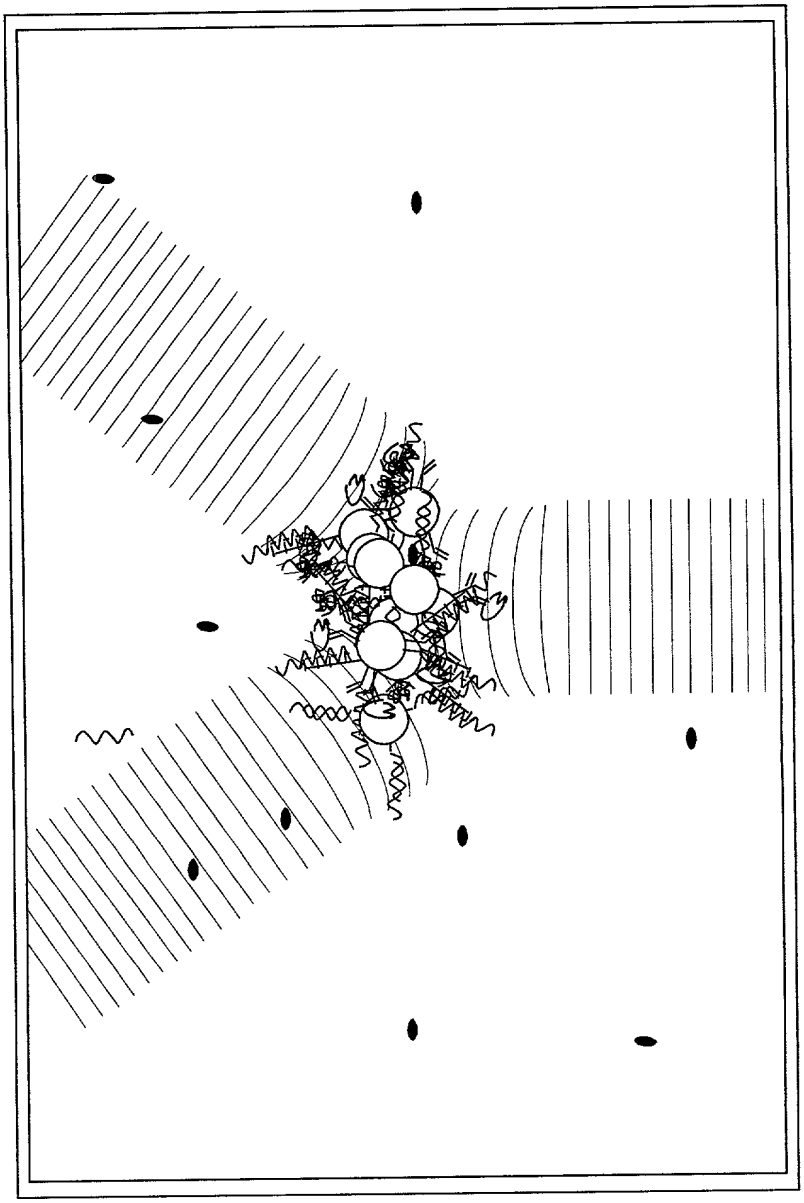


Figure 13A

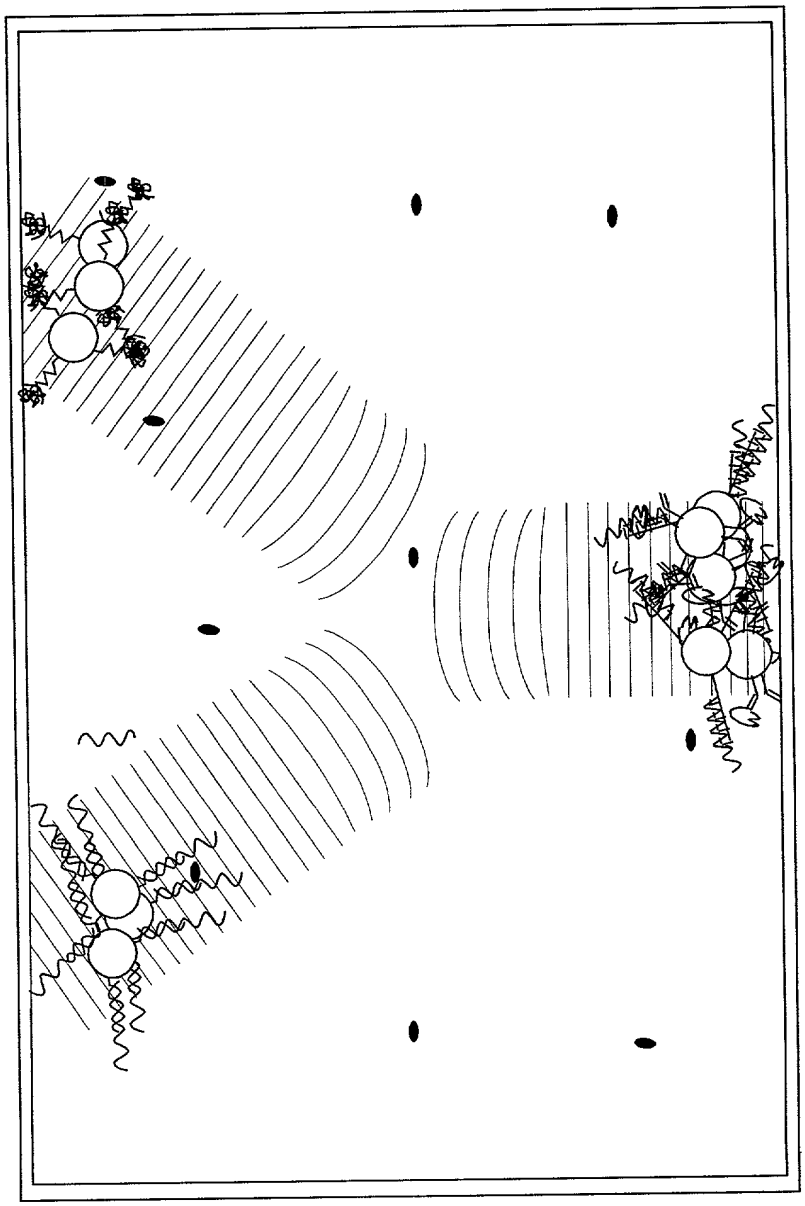


Figure 13B

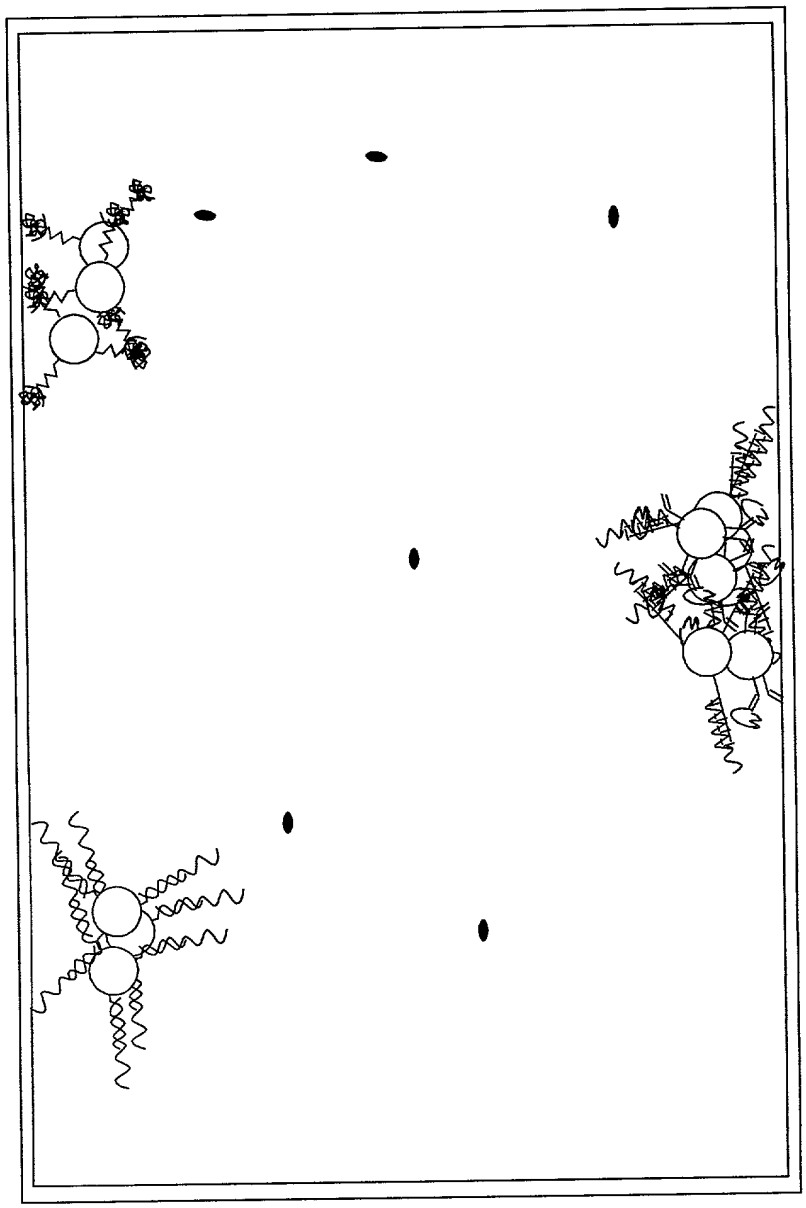


Figure 13C

Figure 14A

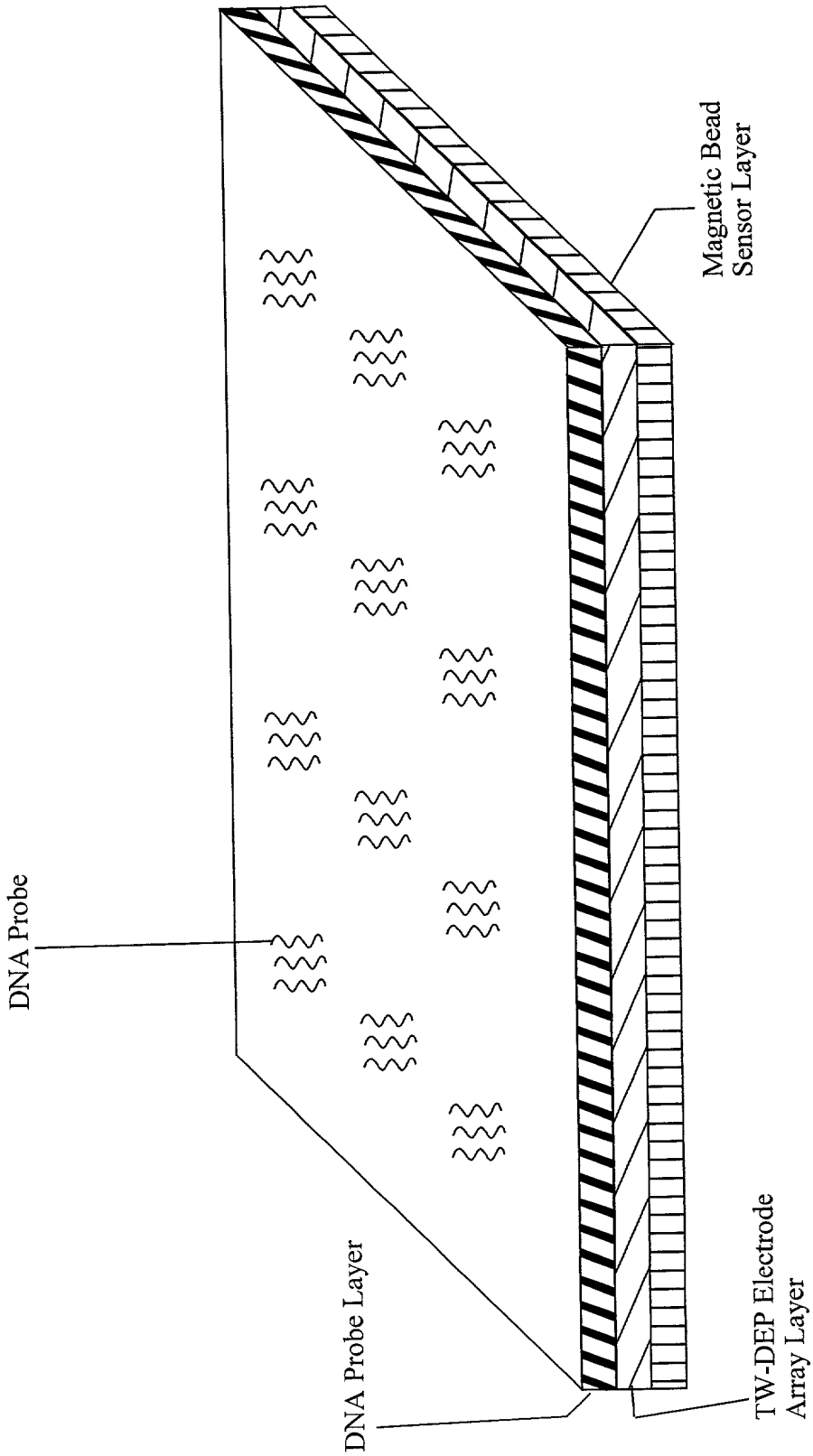

DNA Probe
Magnetic Bead
Sensor Layer
DNA Probe Layer
TW-DEP Electrode
Array Layer

Figure 14B

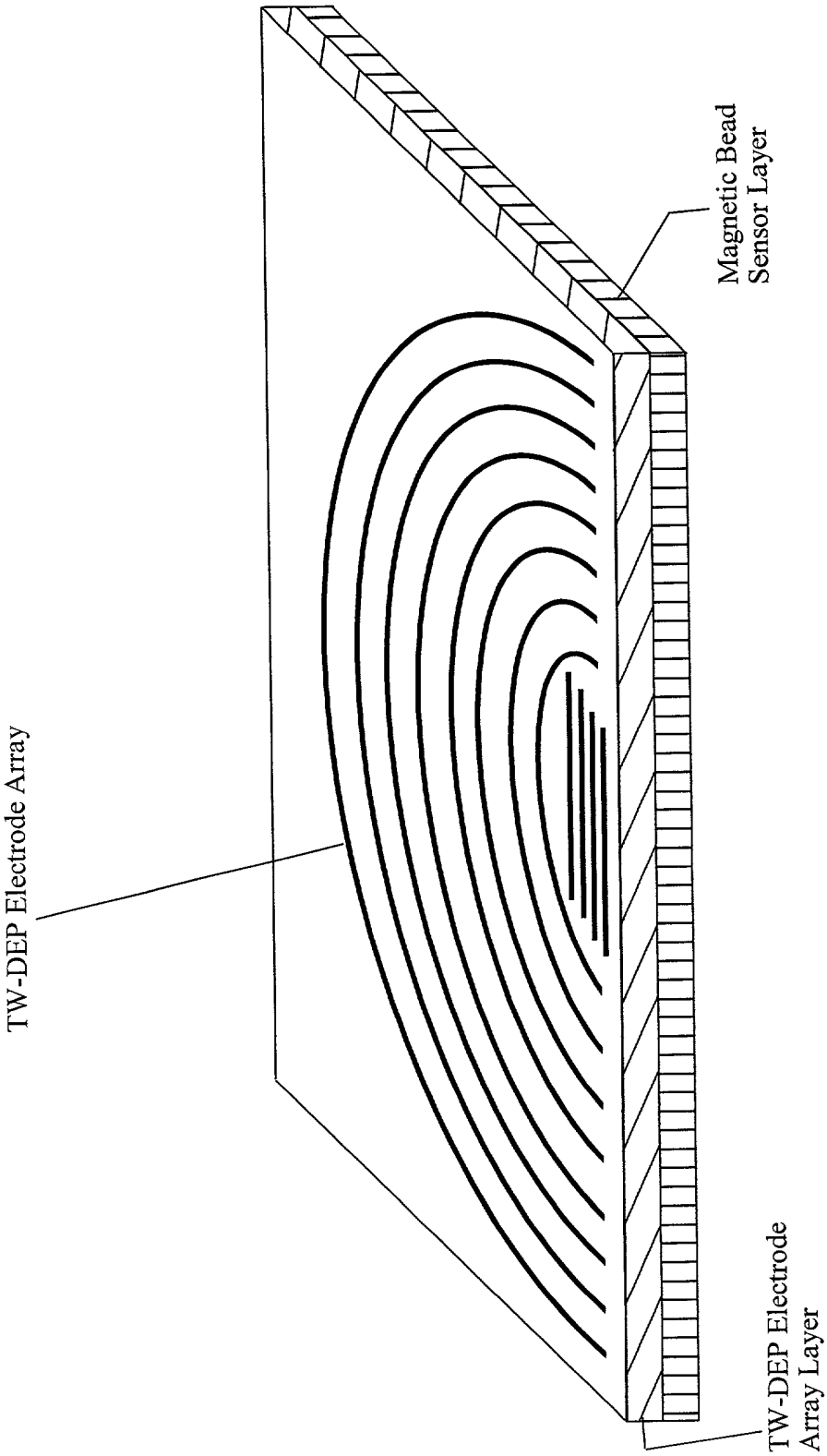
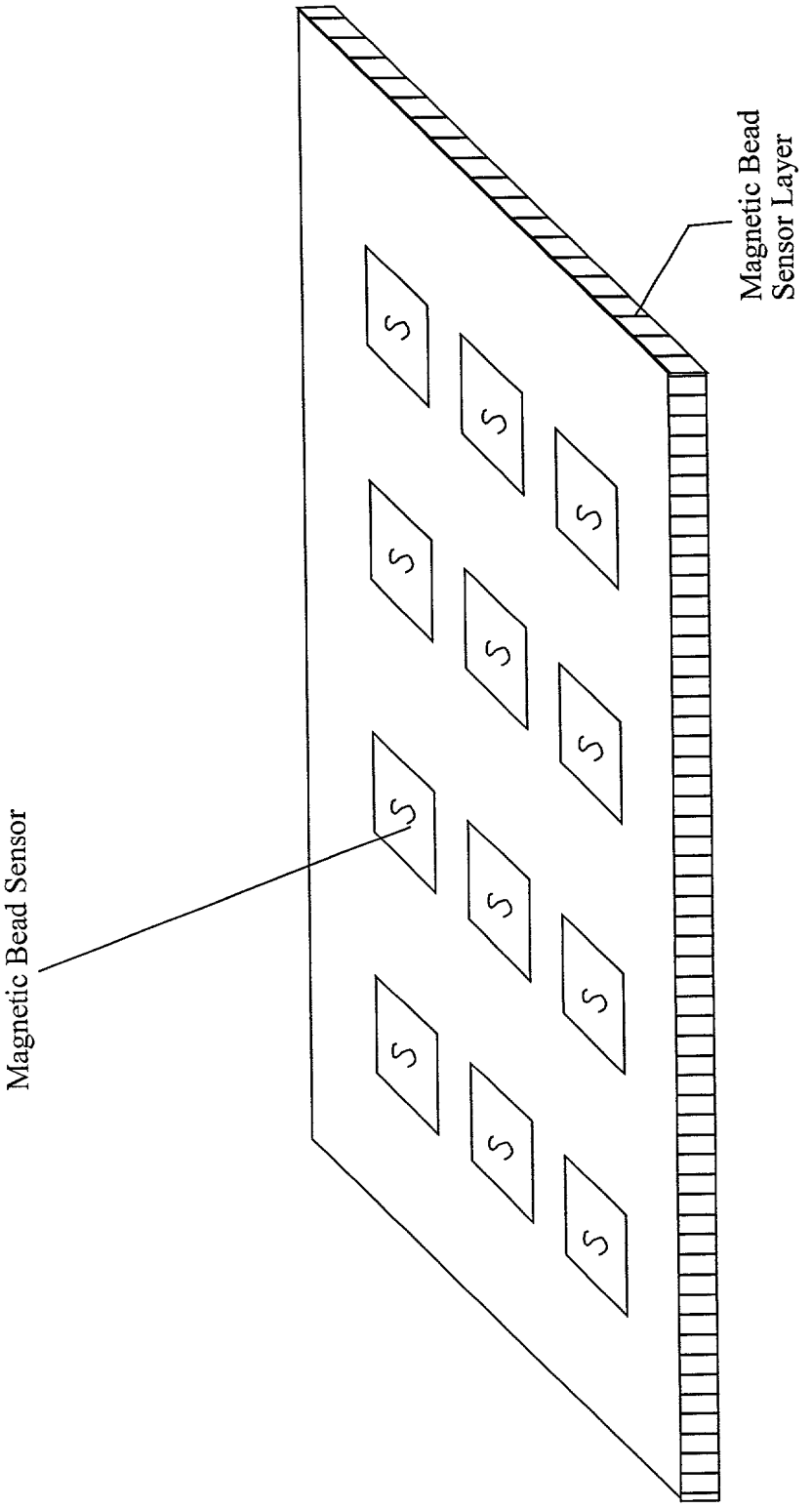

TW-DEP Electrode Array
Magnetic Bead
Sensor Layer
TW-DEP Electrode
Array Layer

Figure 14C



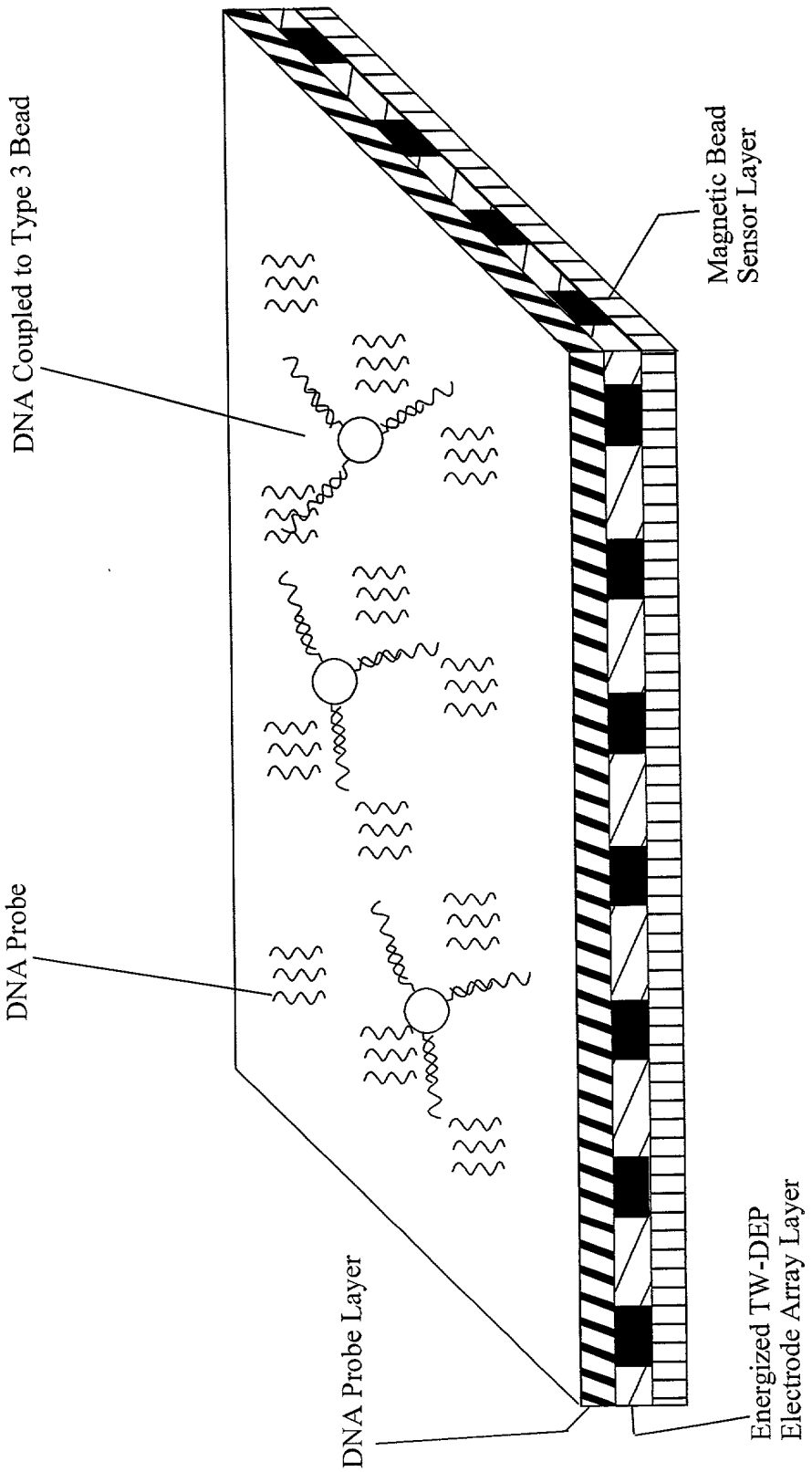

DNA Coupled to Type 3 Bead
DNA Probe
DNA Probe Layer
Magnetic Bead
Sensor Layer
Energized TW-DEP
Electrode Array Layer

Figure 14D

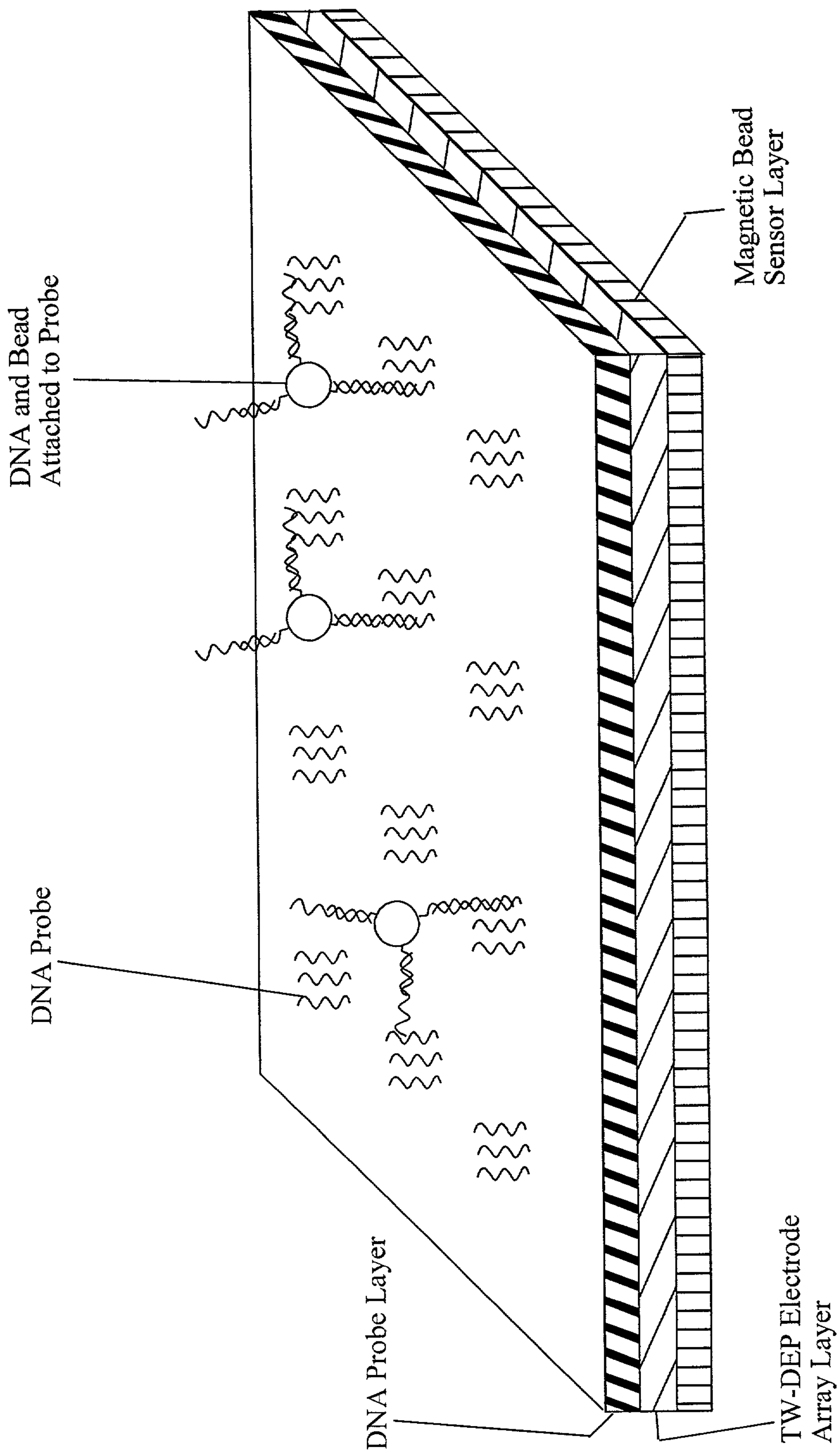

DNA and Bead
Attached to Probe
DNA Probe
Magnetic Bead
Sensor Layer
DNA Probe Layer
TW-DEP Electrode
Array Layer

Figure 14E

Figure 14F

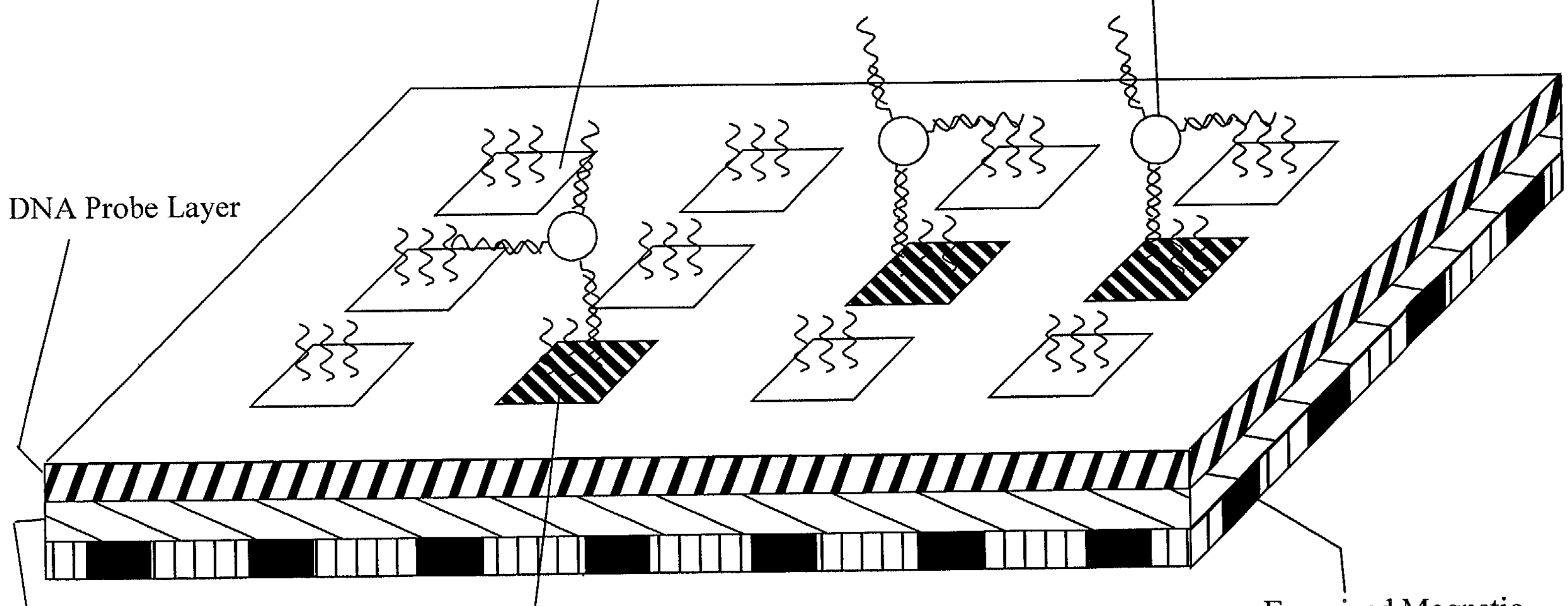

Bead Sensor
DNA Coupled to
Type 3 Bead Bound
to DNA Probe
DNA Probe Layer
TW-DEP Electrode
Array Layer
The presence of magnetic beads is detected
by the responses from magnetic beads
sensors, indicated by black and white strips.
Energized Magnetic
Bead Sensor Layer

Figure 15A

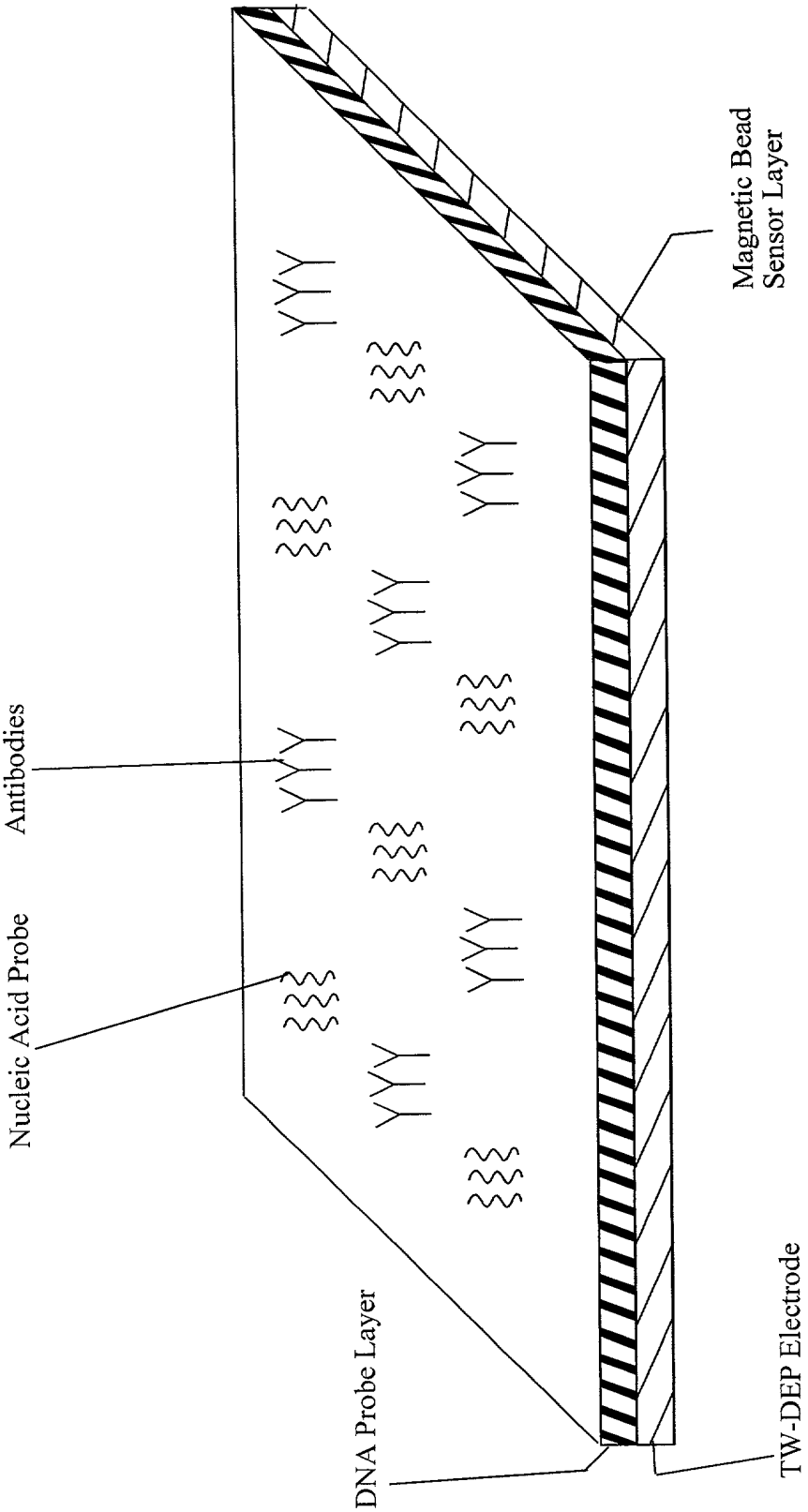

Nucleic Acid Probe
Antibodies
Magnetic Bead
Sensor Layer
DNA Probe Layer
TW-DEP Electrode
Array Layer

Figure 15B

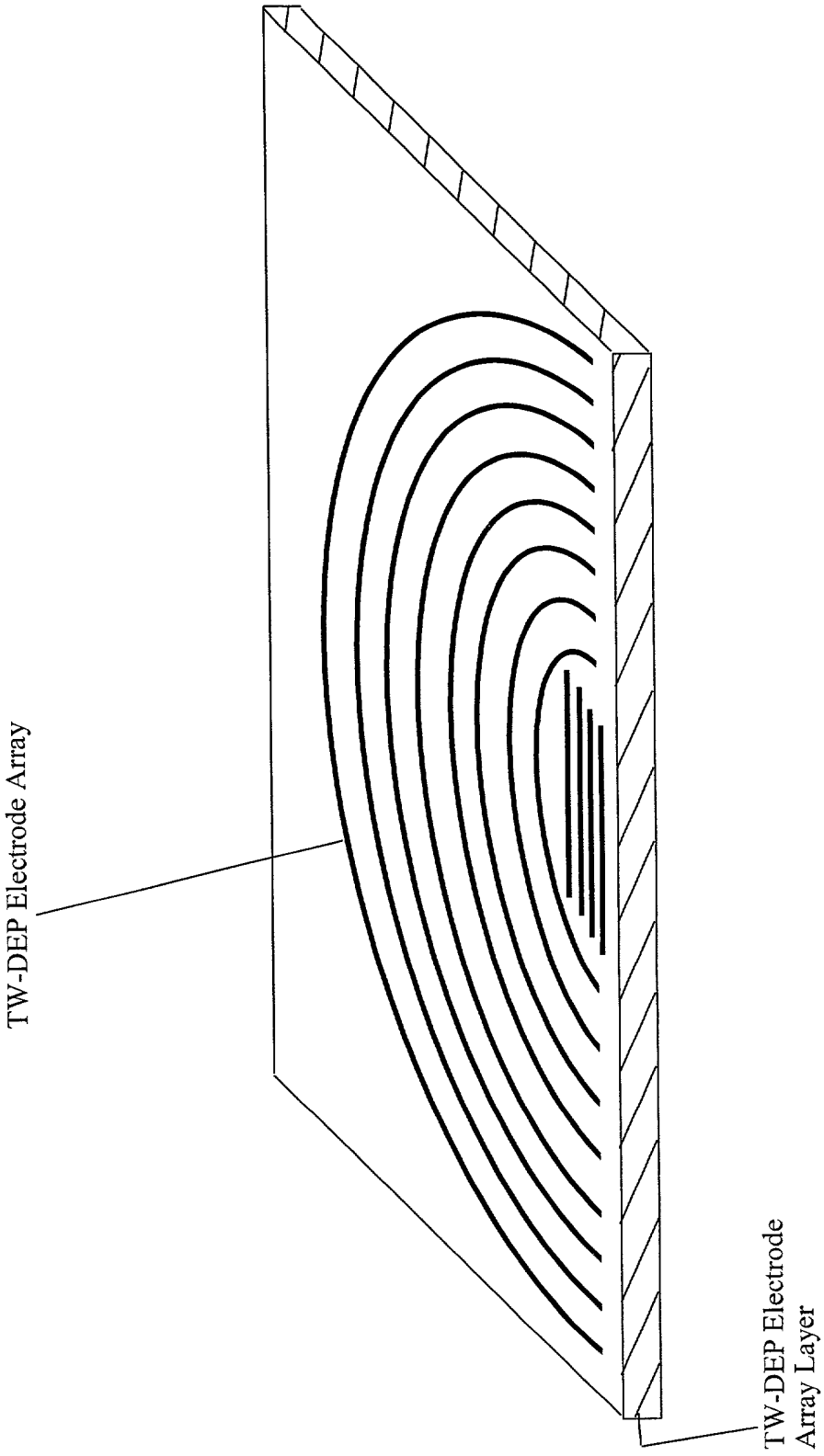


Figure 15C

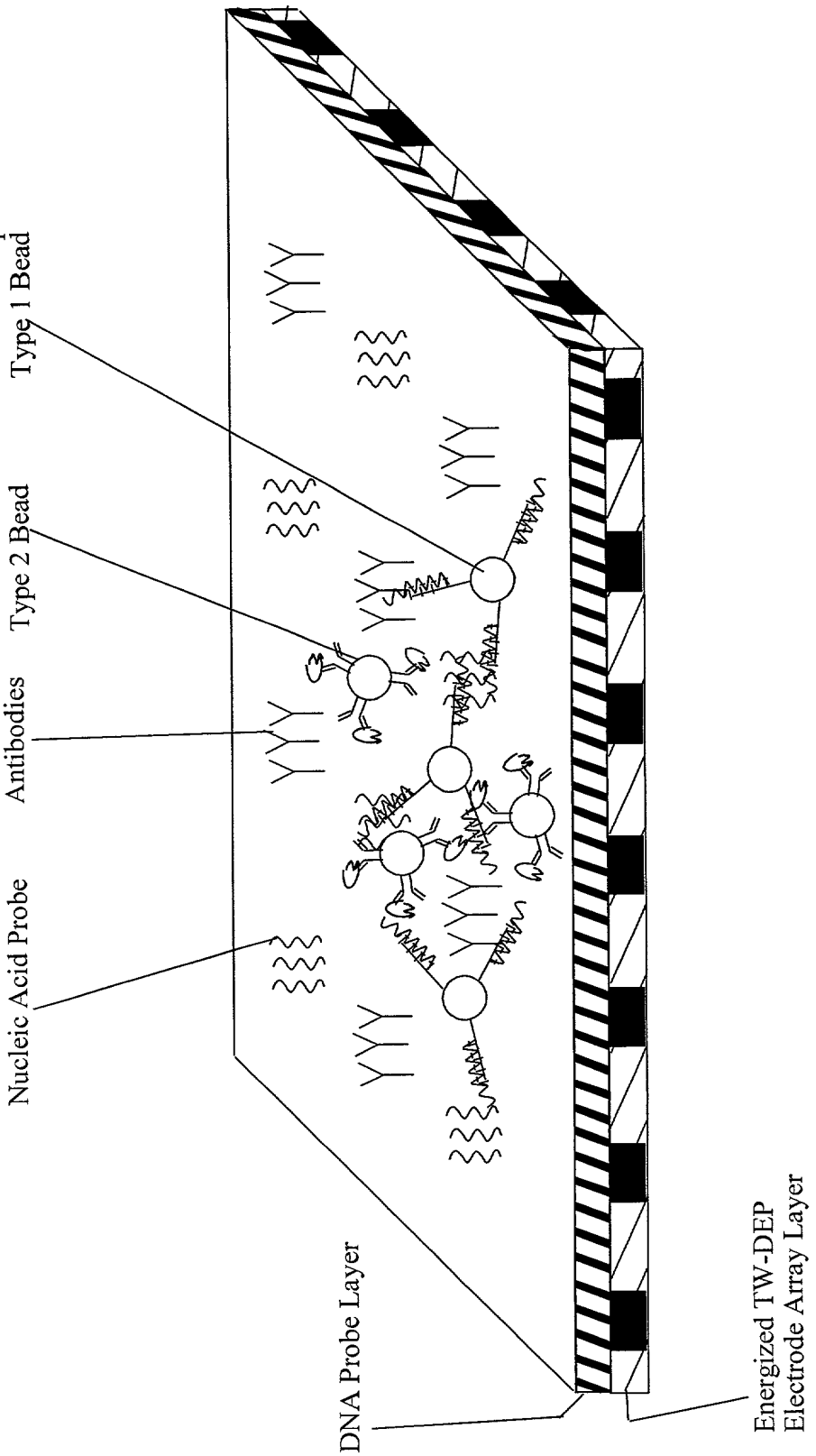
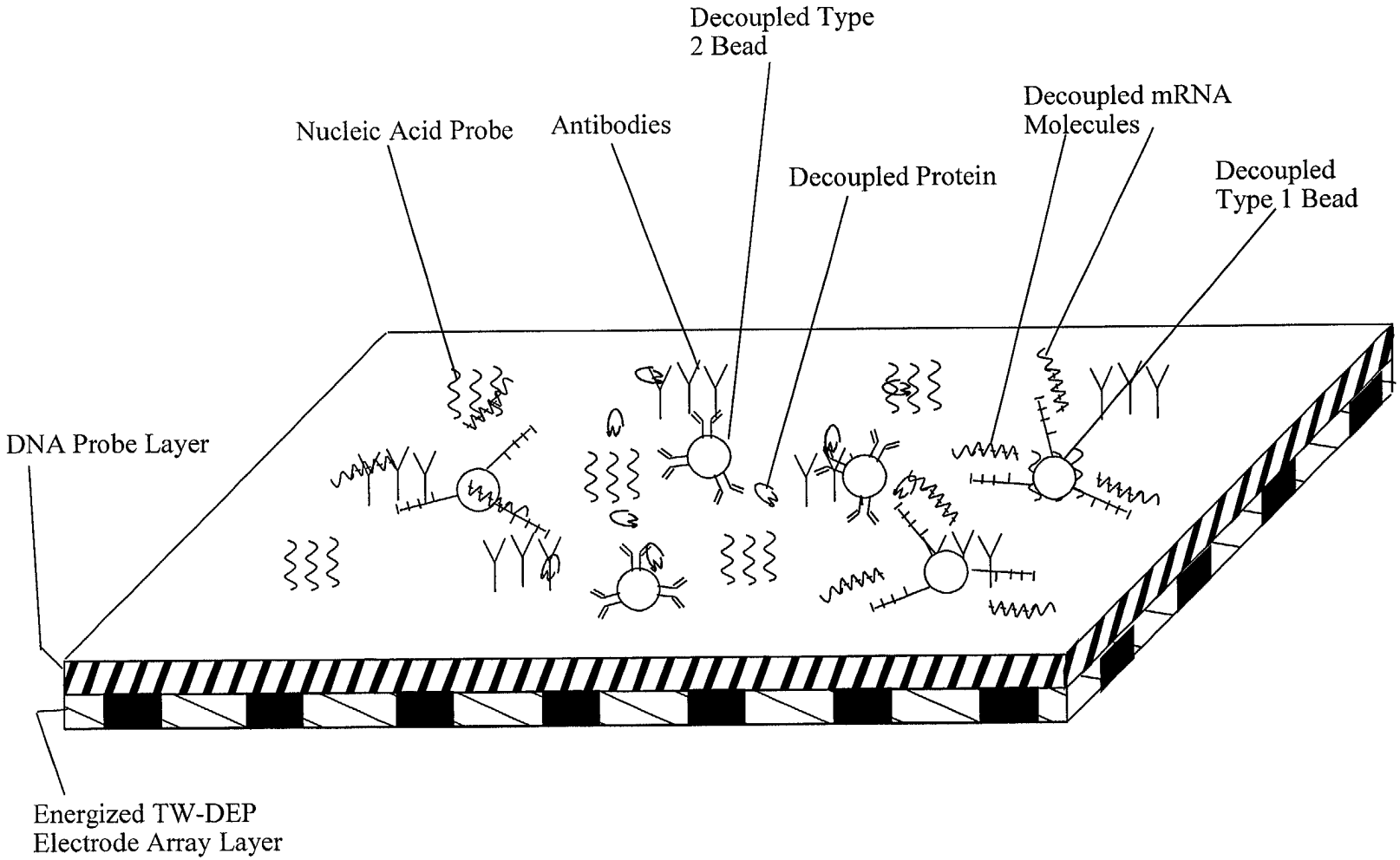

mRNA Couple to Type 1 Bead
Protein Bound to Type 2 Bead
Antibodies
Nucleic Acid Probe
DNA Probe Layer
Energized TW-DEP Electrode Array Layer

Figure 15D


Decoupled Type
2 Bead
Nucleic Acid Probe
Antibodies
Decoupled mRNA
Molecules
Decoupled Protein
Decoupled
Type 1 Bead
DNA Probe Layer
Energized TW-DEP
Electrode Array Layer

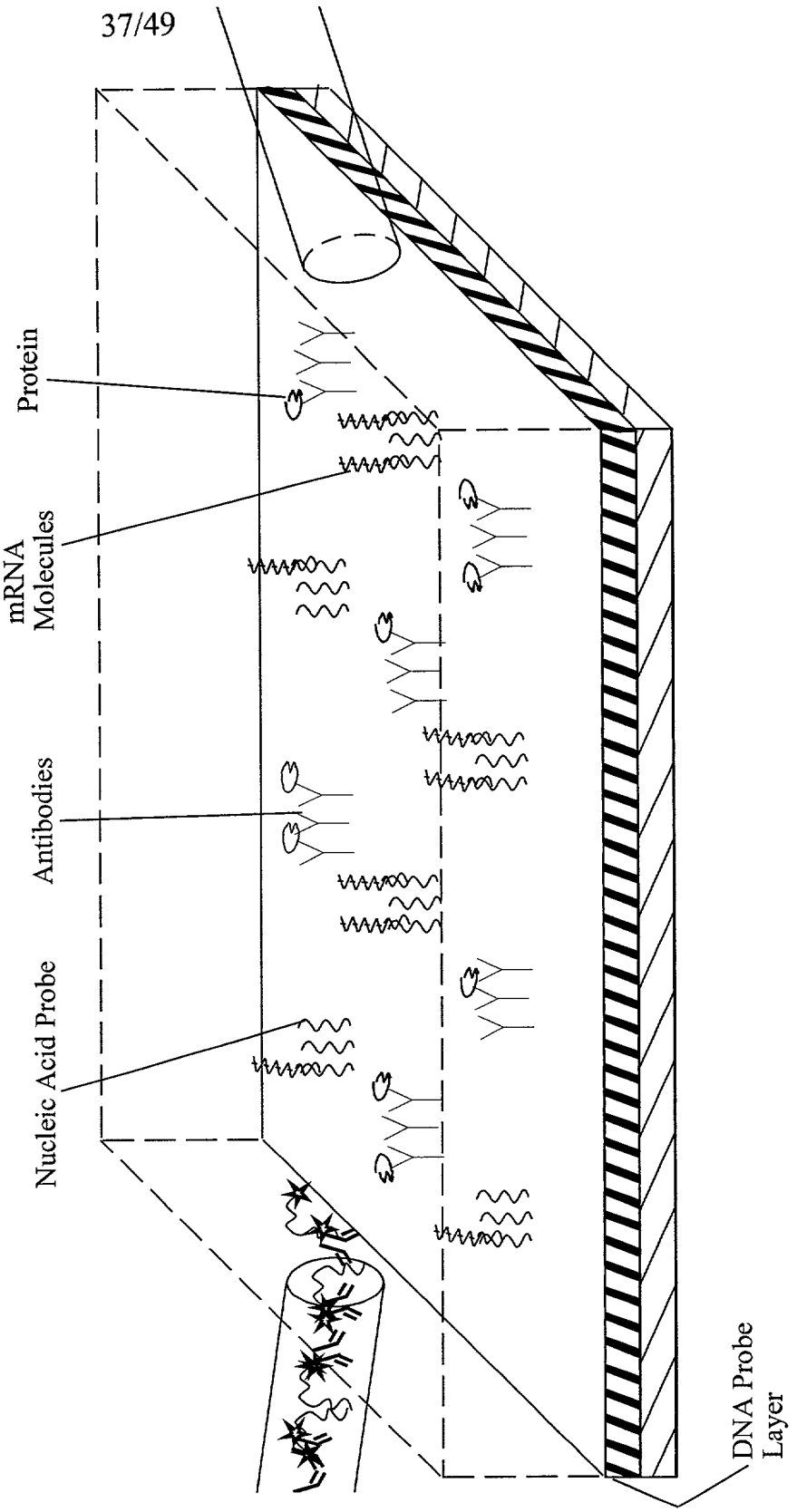

Protein
mRNA Molecules
Antibodies
Nucleic Acid Probe
DNA Probe Layer

Figure 15E

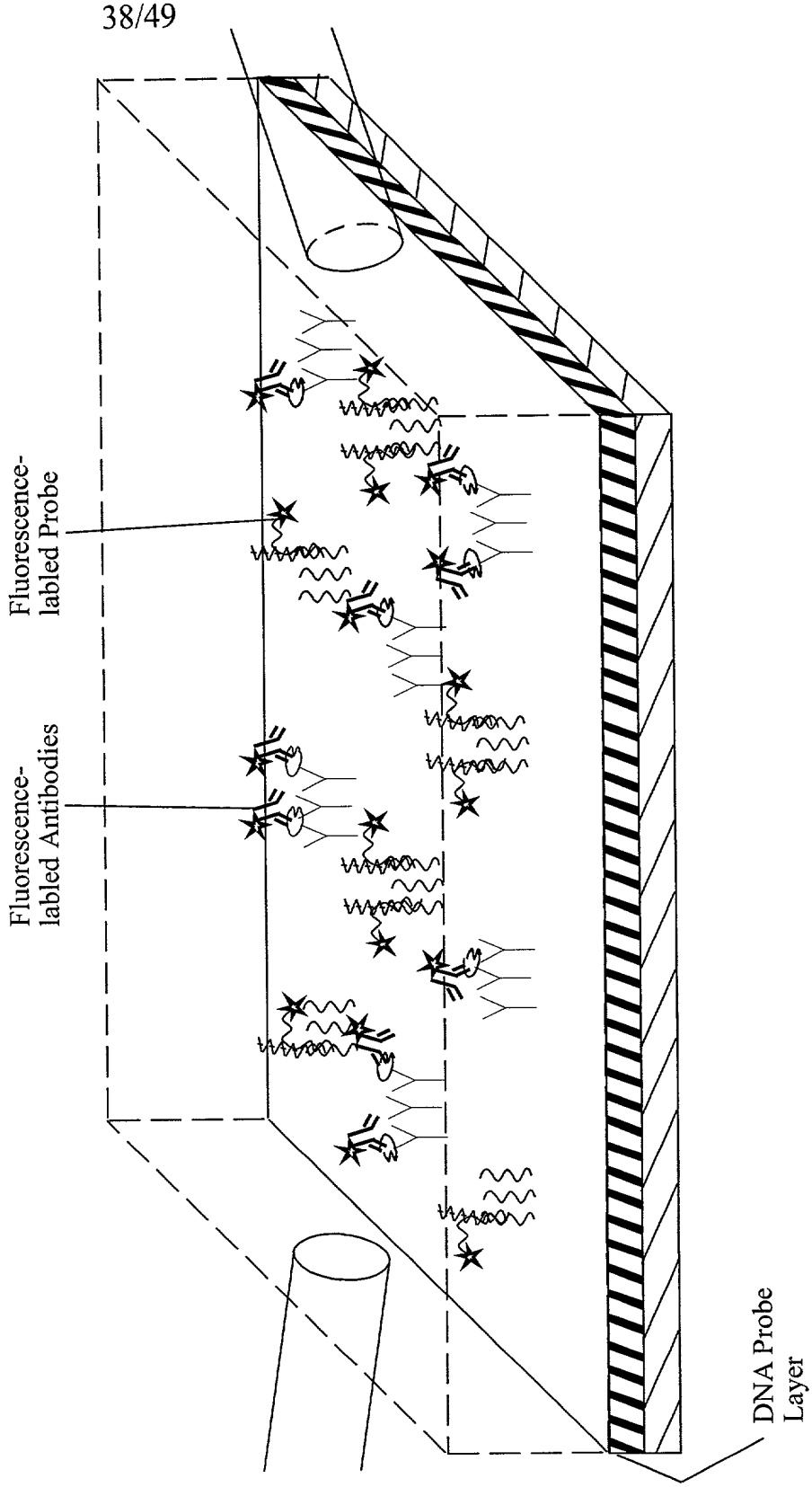

Fluorescence-
labled Probe
Fluorescence-
labled Antibodies
DNA Probe
Layer

Figure 15F

Figure 16A

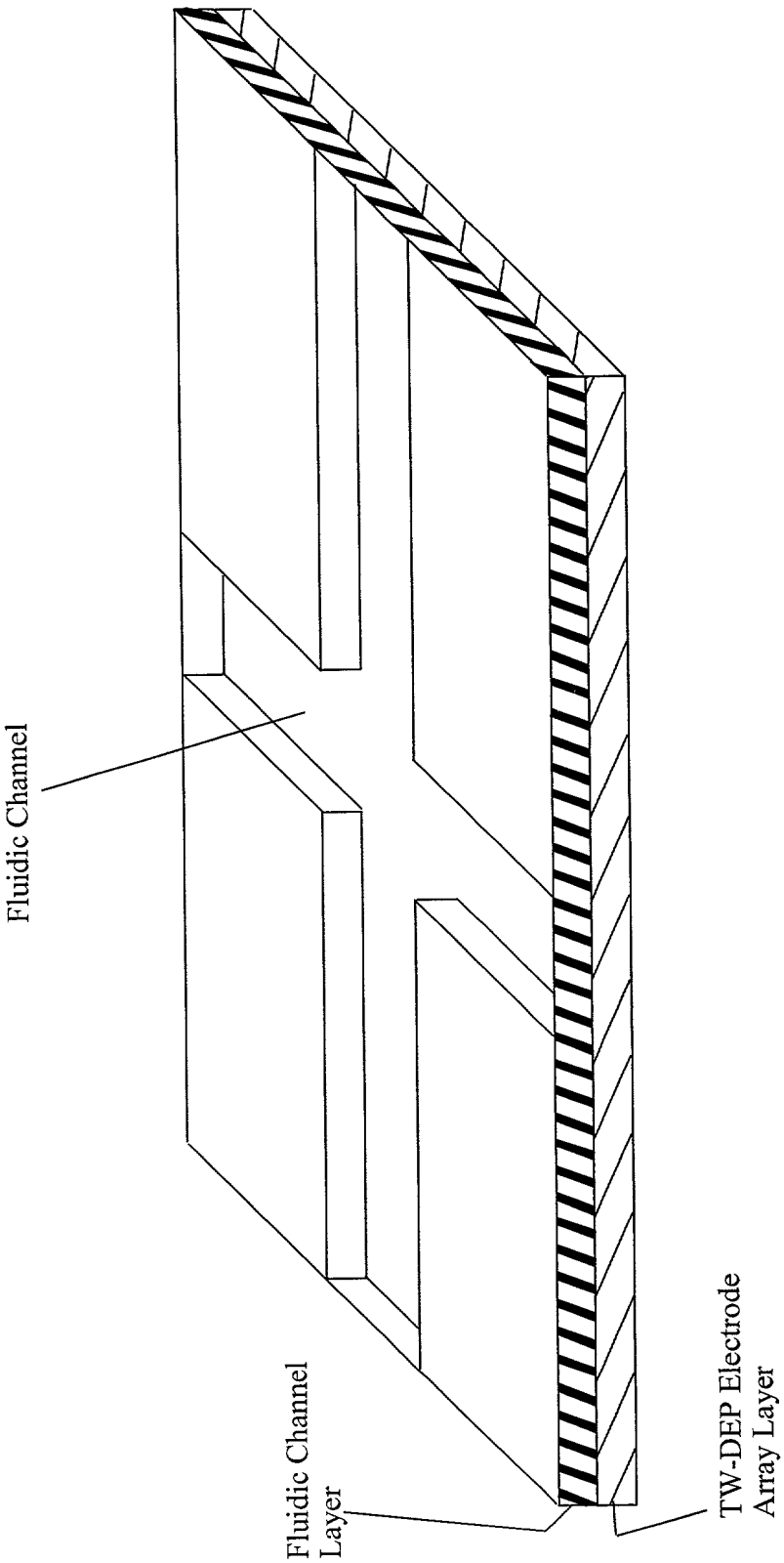

Fluidic Channel
Fluidic Channel Layer
TW-DEP Electrode Array Layer

Figure 16B

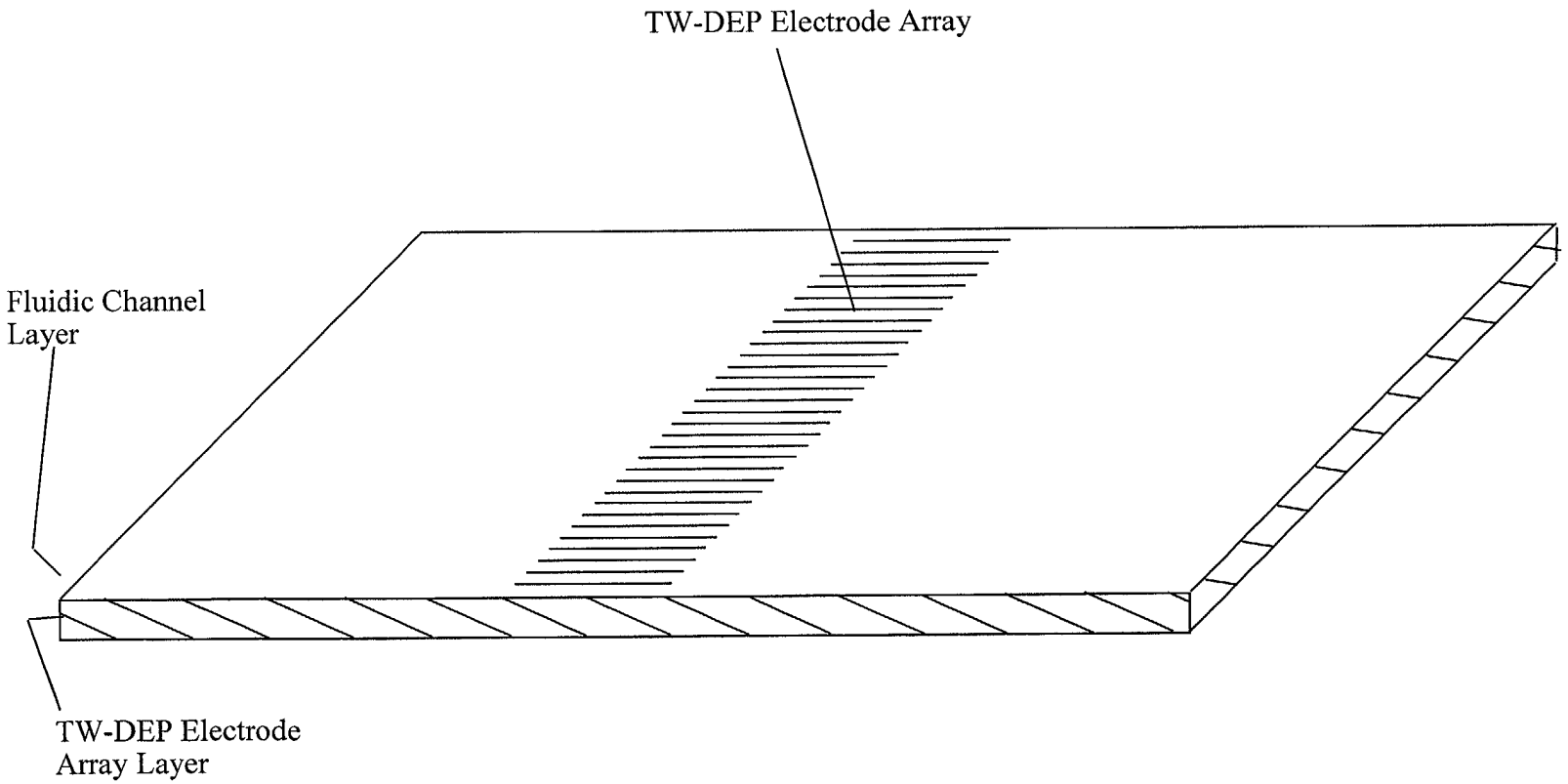


Figure 16C

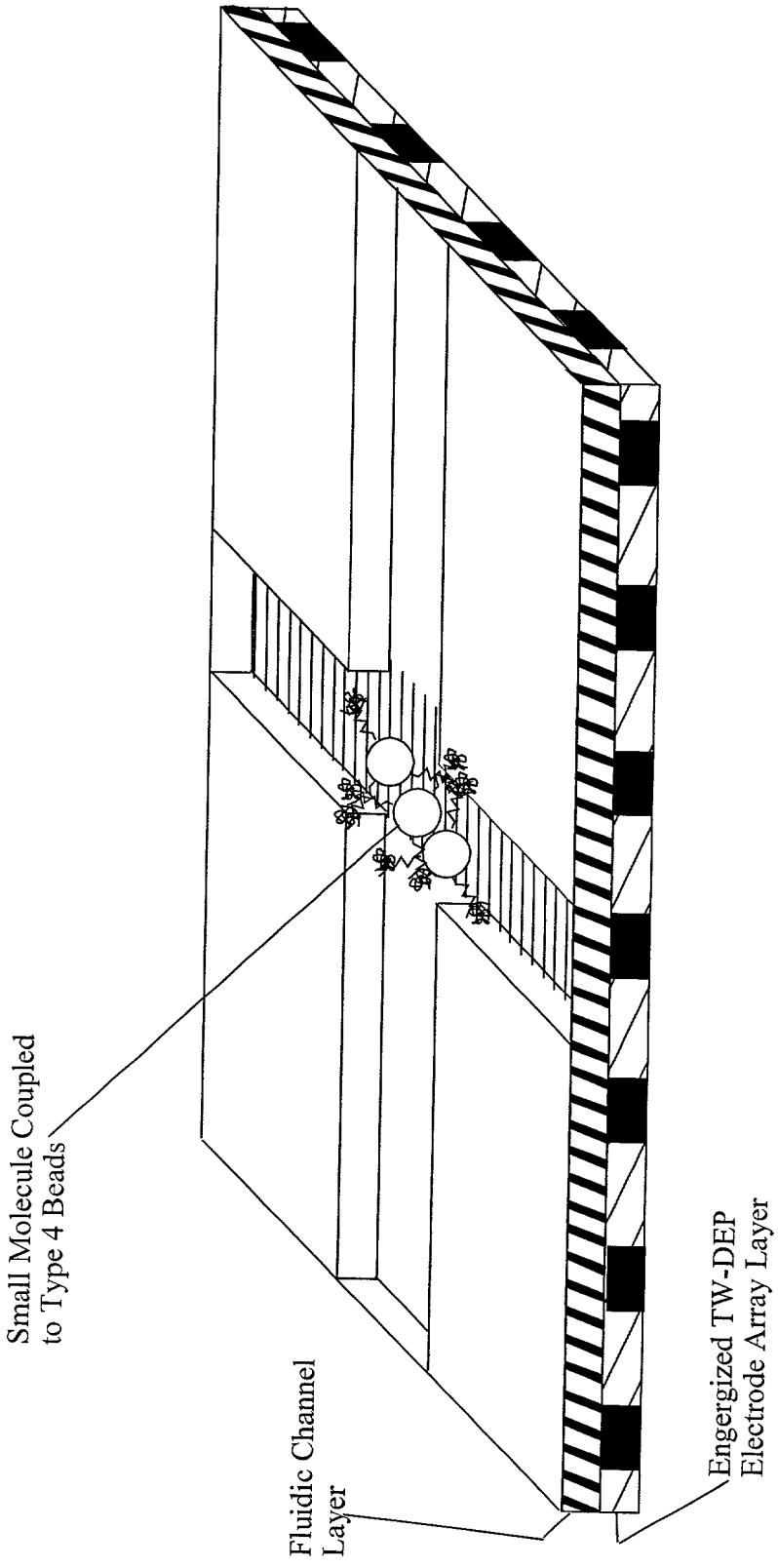

Small Molecule Coupled
to Type 4 Beads
Fluidic Channel
Layer
Engergized TW-DEP
Electrode Array Layer

Figure 16D

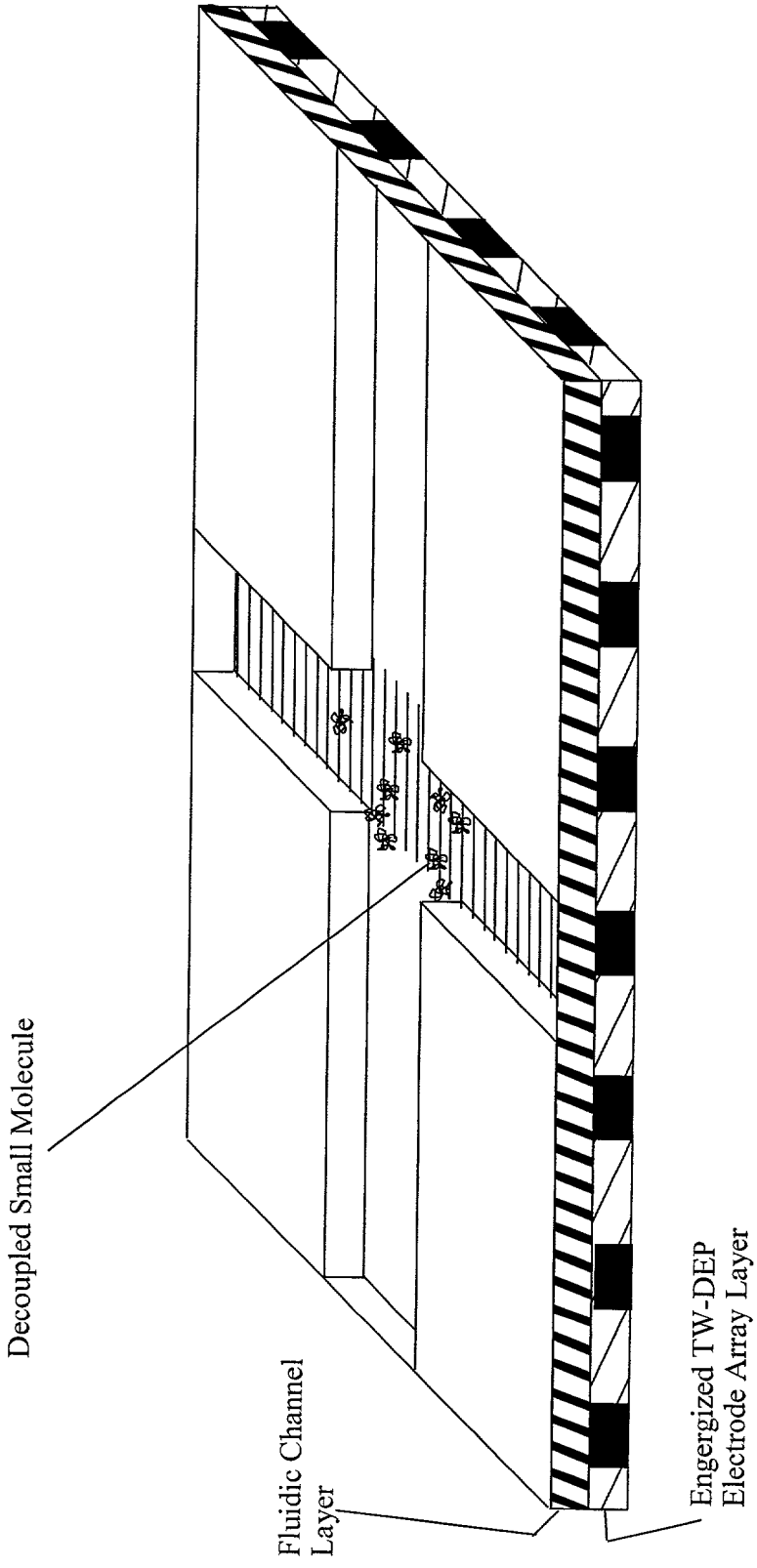

Decoupled Small Molecule
Fluidic Channel Layer
Engergized TW-DEP Electrode Array Layer

Figure 16E

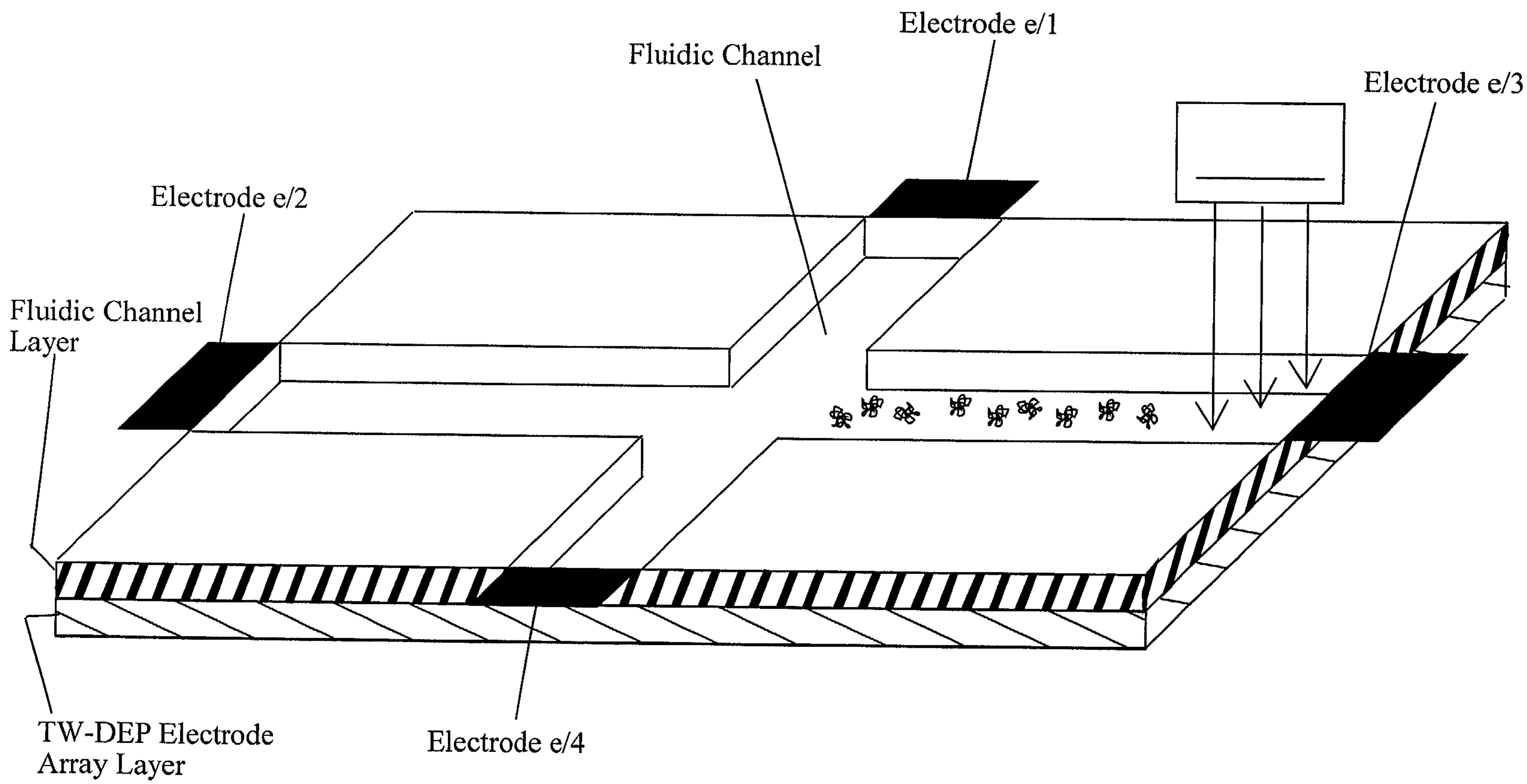

Electrode e/1
Fluidic Channel
Electrode e/3
Electrode e/2
Fluidic Channel Layer
TW-DEP Electrode Array Layer
Electrode e/4

Figure 16F

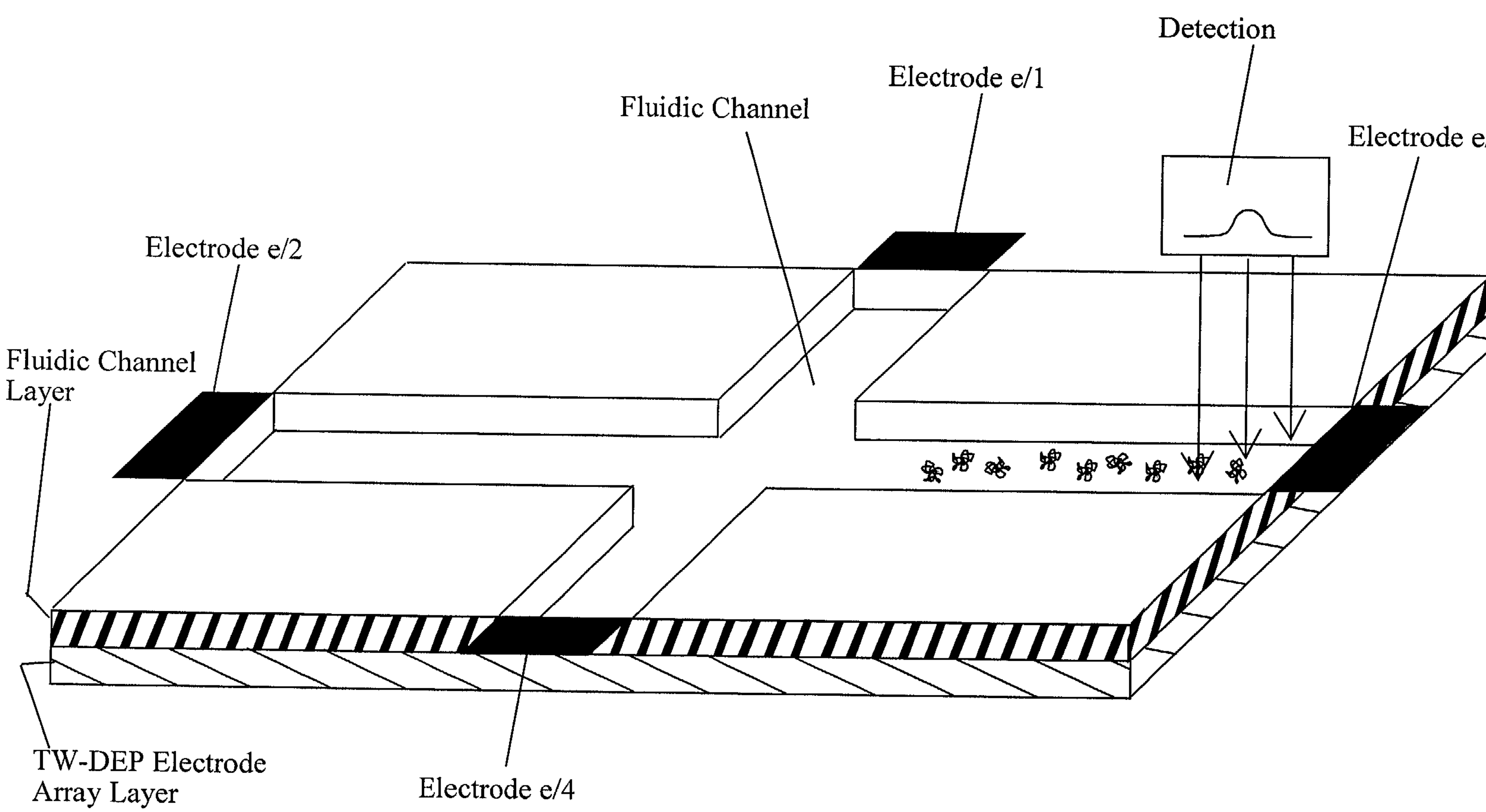


Figure 17

SINGLE CHIP SYSTEM

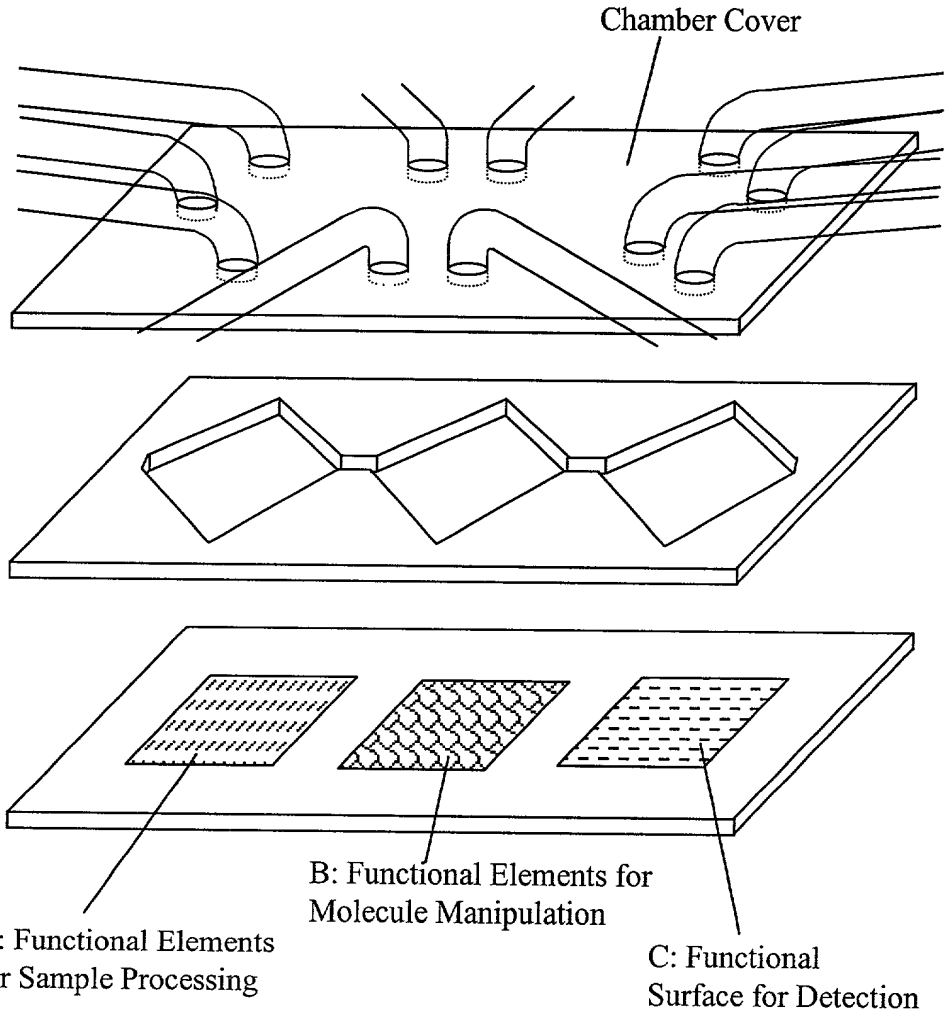
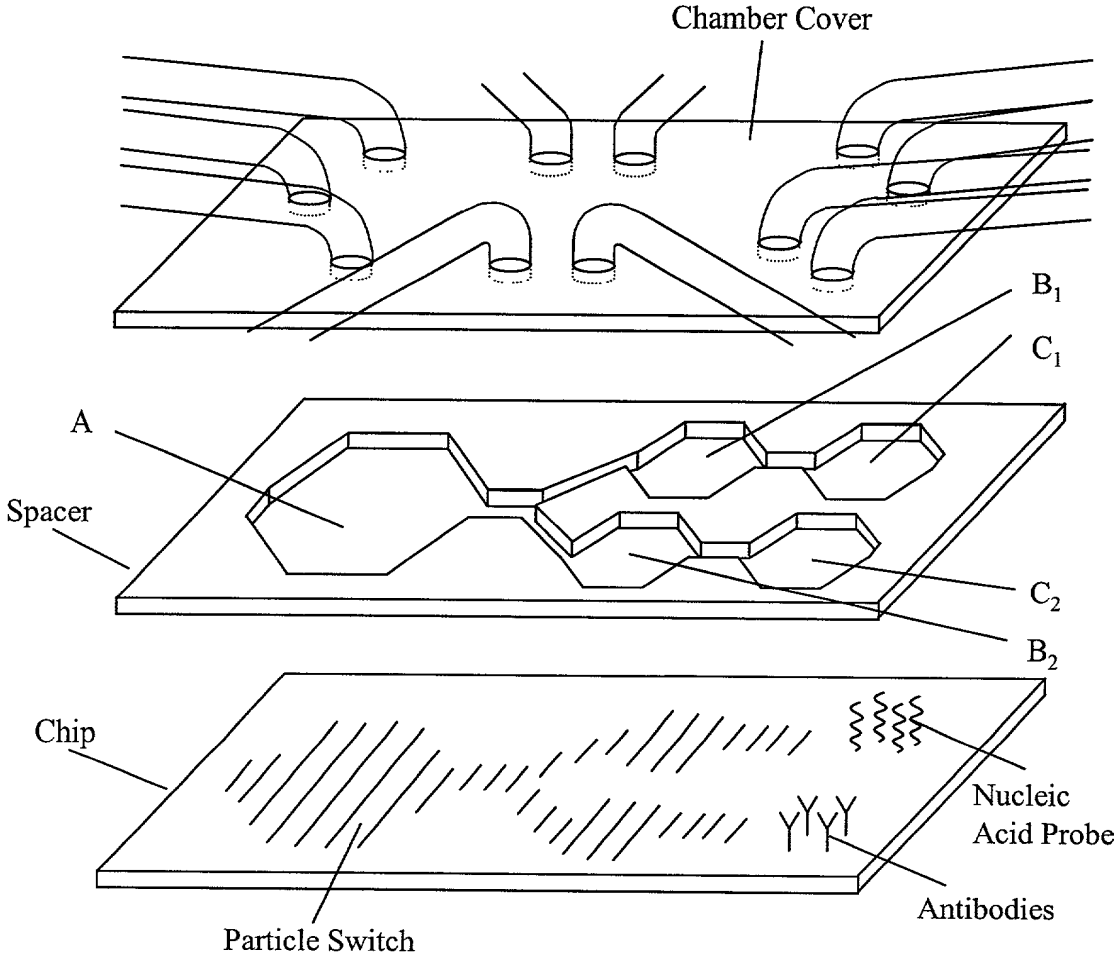
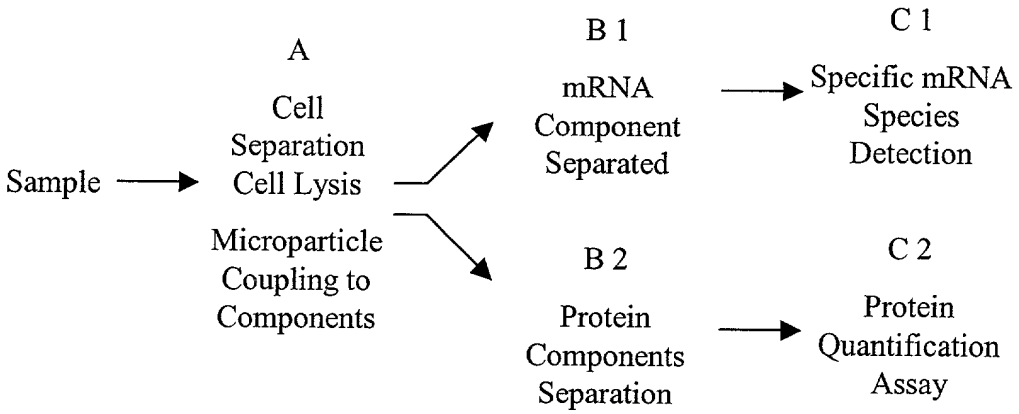


Figure 18


Chamber Cover
B1
C1
A
Spacer
C2
B2
Chip
Nucleic
Acid Probe
Antibodies
Particle Switch


A
B 1
C 1
Cell
Separation
Cell Lysis
mRNA
Component
Separated
Specific mRNA
Species
Detection
Sample
Microparticle
Coupling to
Components
B 2
C 2
Protein
Components
Separation
Protein
Quantification
Assay

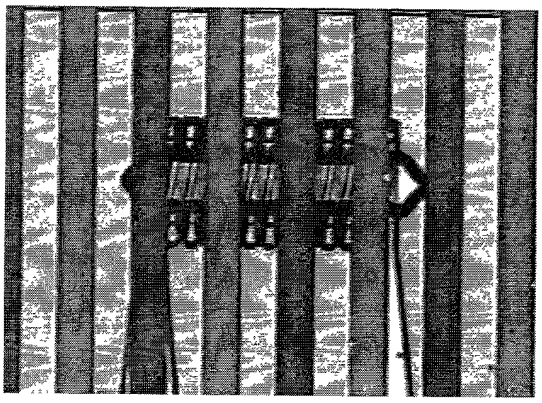


Figure 19A

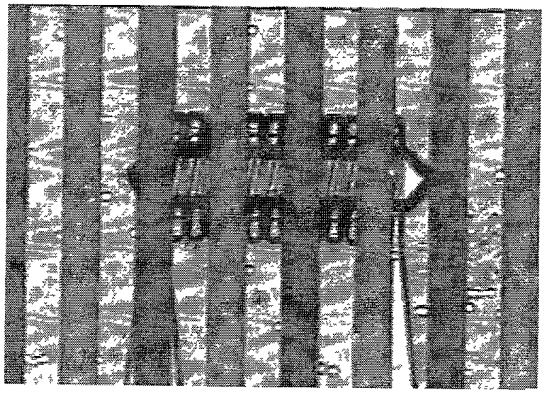


Figure 19B

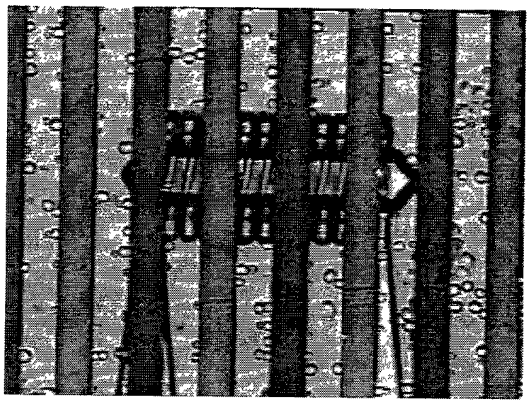


Figure 19C

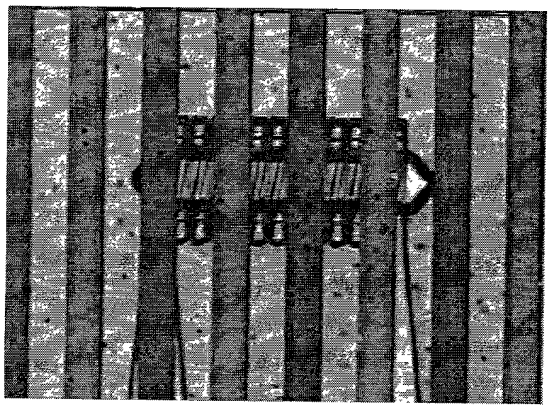


Figure 19D

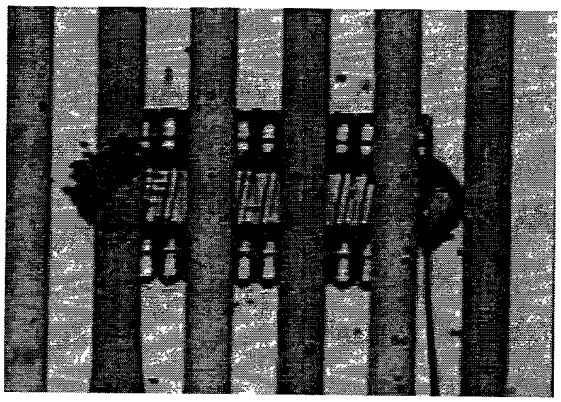


Figure 19E

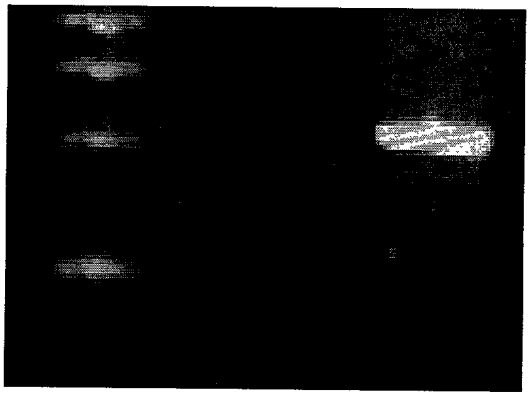


Figure 19F